Legacy that Inspires the Future

भारतीय प्रौद्योगिकी संस्थान
भारतीय खनि विद्यापीठ
धनबाद

IIT ISM INDIAN INSTITUTE OF TECHNOLOGY INDIAN SCHOOL OF MINES DHANBAD

Department of Applied Geophysics

WELL LOG CASE STUDY GPC-510

IchthysDeep-1 Well, NWS, Western Australia

Instructor - Dr. Partha Pratim Mandal

By - Amrit Krishn

CASE STUDY OBJECTIVES

1. Sonic Tool Instrumentation
2. Quality Control Of Wire Line Logs
3. Porosity Determination
4. Velocity Depth Profiling
5. Water Saturation Calculation
6. Reservoir Characterization
7. Statistical Analysis For Reservoir

Abstract Of the well

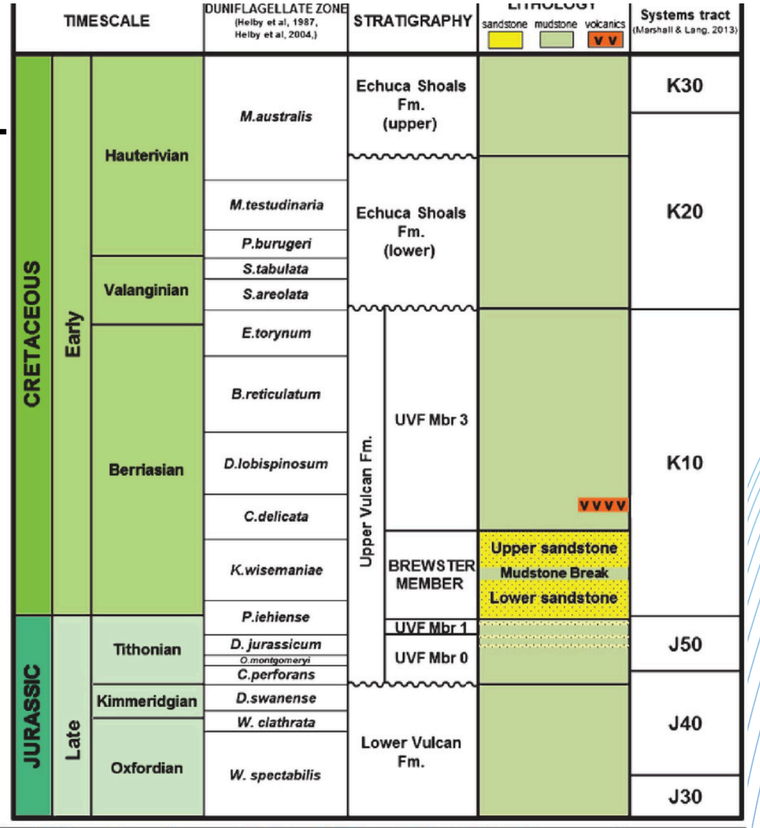
Ichthys Deep 1 Well

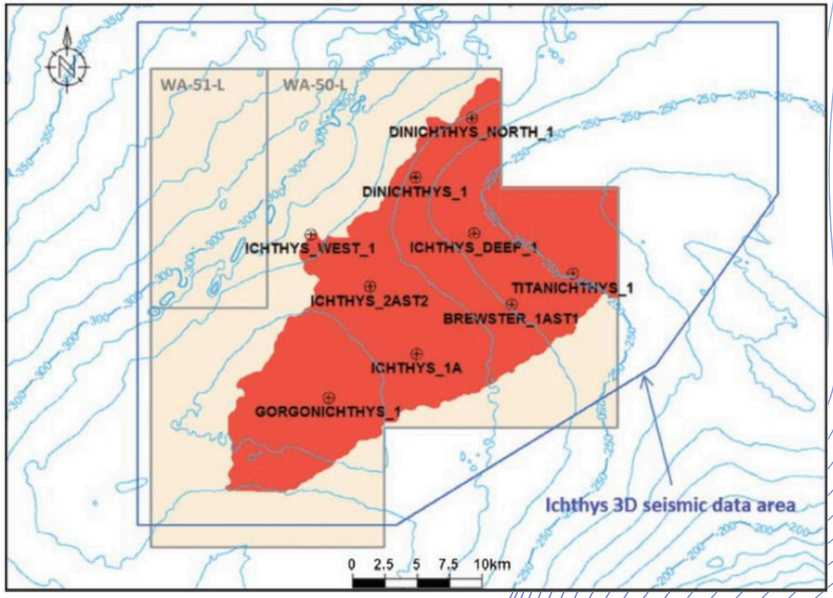
Our objective is to Analyze the **Brewster Member**

Depth range- 4074.5 - 4242 m

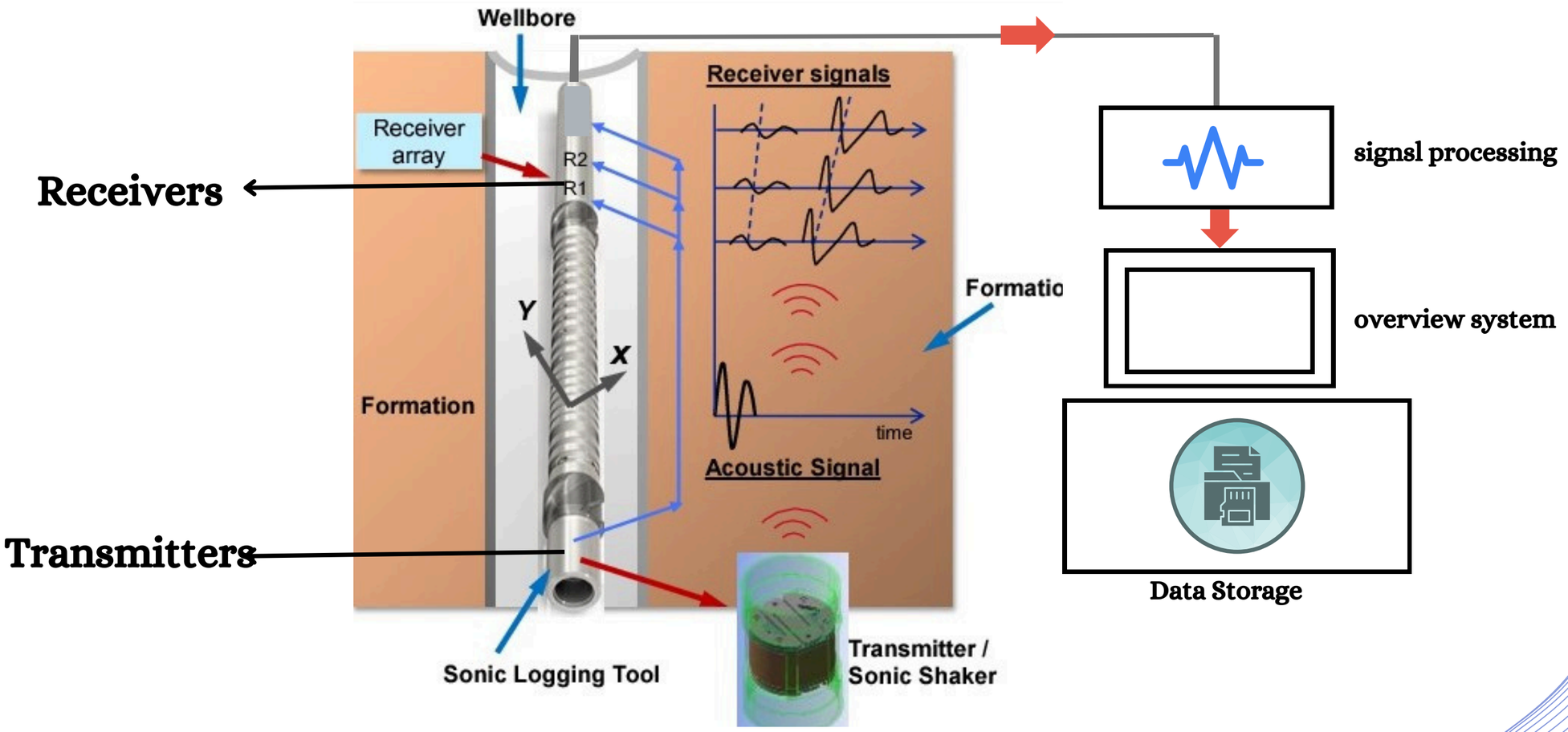
Important logs in data

- Depth of well denoted by ‘DEPTH’
- Gamma Ray values denoted by ‘GR’
- Caliper values denoted by ‘CALI’
- Neutron porosity of well denoted by ‘NEUT’
- Bulk Density denoted by ‘RHOM’
- Shallow Resistivity denoted by ‘RESS’
- Deep Resistivity denoted by ‘RESD’
- Transit time of P-wave denoted by ‘DT’
- Transit time of S-wave denoted by ‘DTCO’





1. Instrumentation requirement to design a sonic Tool



Dual Receiver Seismic Tool

1. Instrumentation requirement to design a sonic Tool

Cost Estimate of the sonic tool:

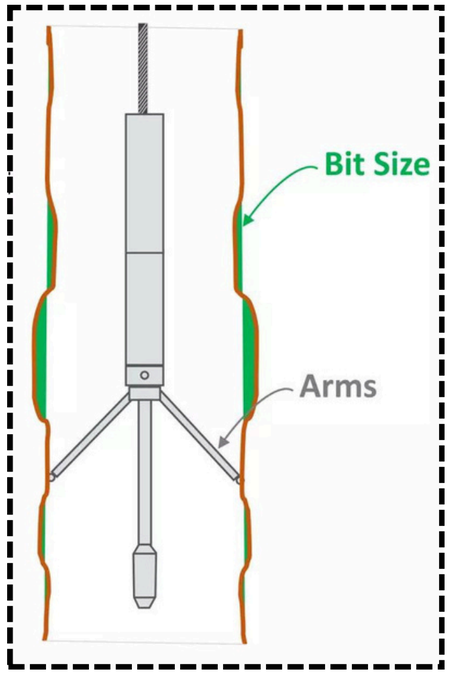
1. Receivers: $ 500 - 5000
2. Transmitters: $ 1000 - 5000
3. Electronics: $ 10000 - 15000
4. Casing Material: $ 5000 - 20000

Total cost: $ 16500- 45000

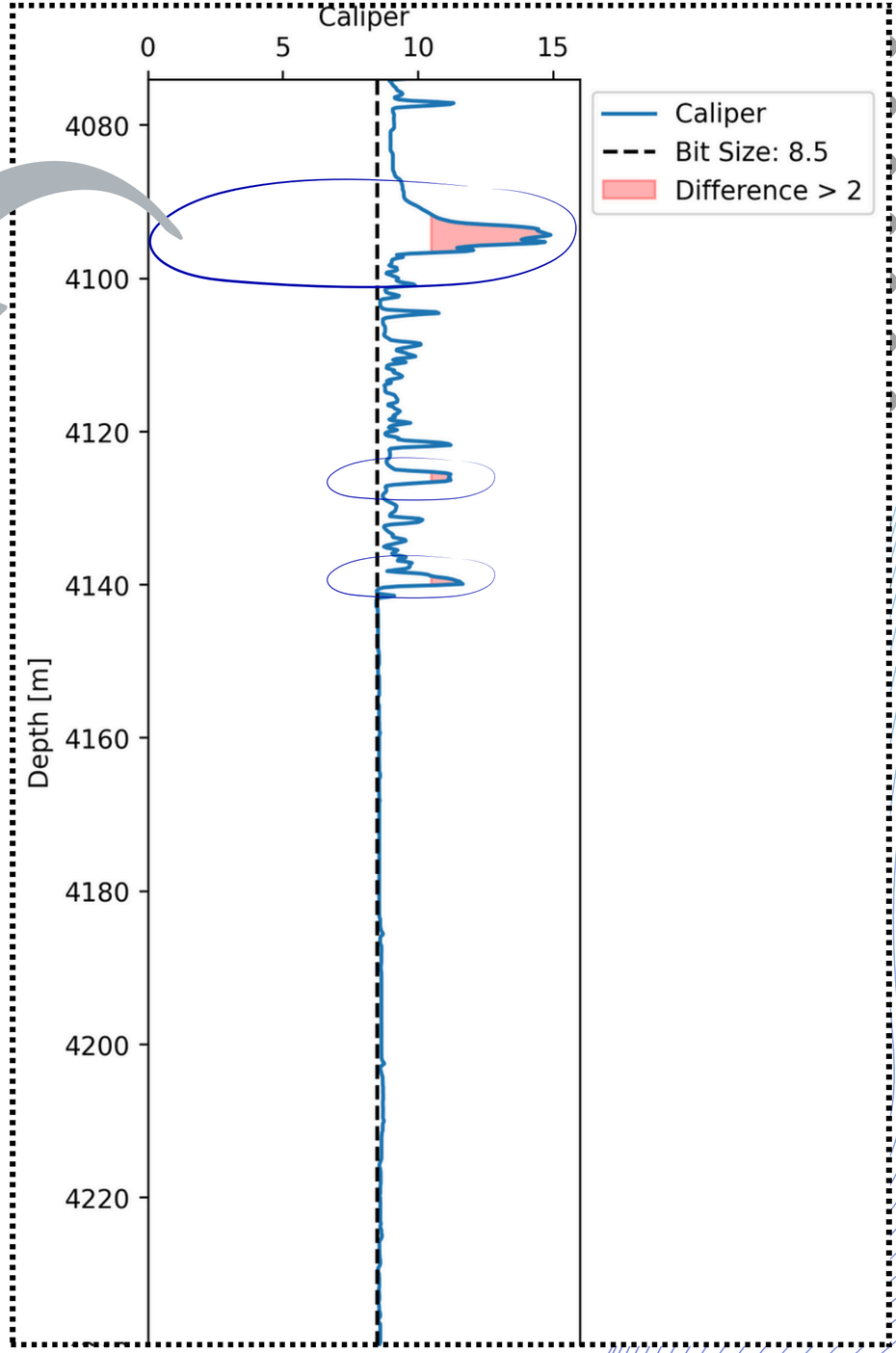
Borehole Quality

- Difference between Caliper and bit size should not be greater than 2 inch, otherwise it will be bad borehole
- If difference is greater than the borehole is called washed-out borehole / elongated borehole.

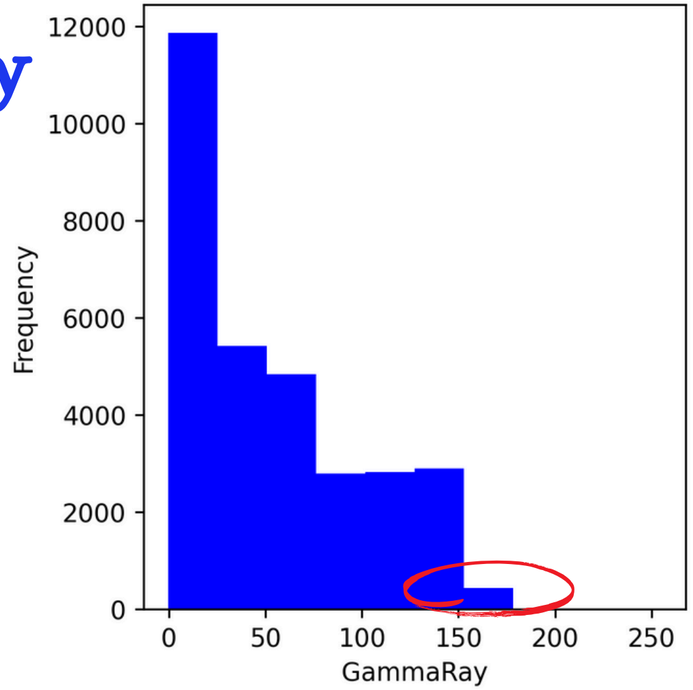
Caved Hole

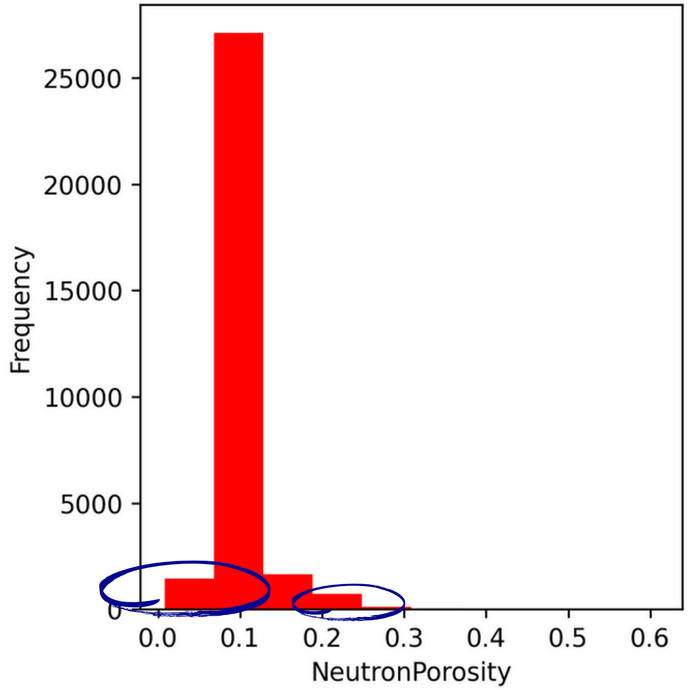


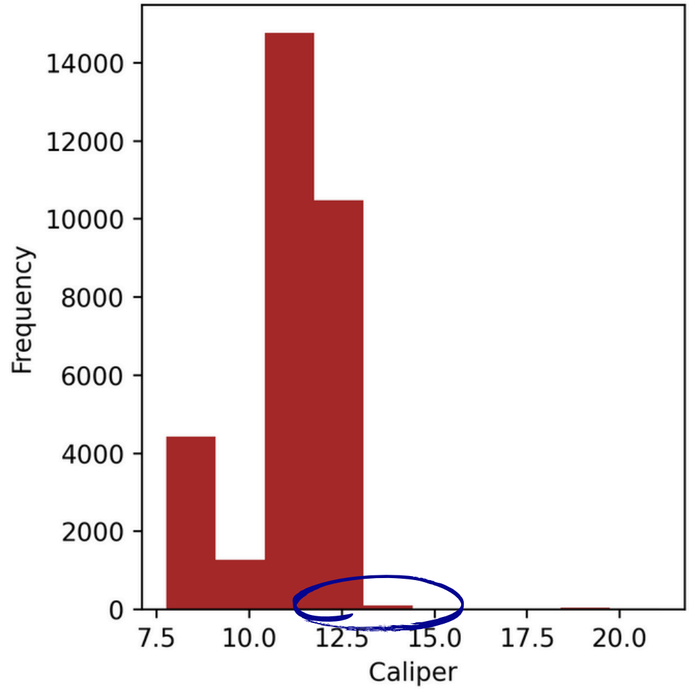
Caliper

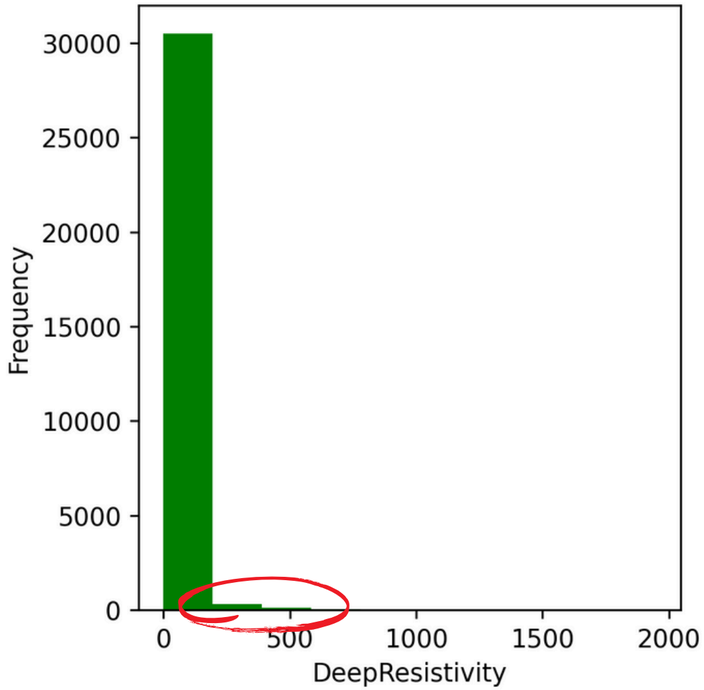


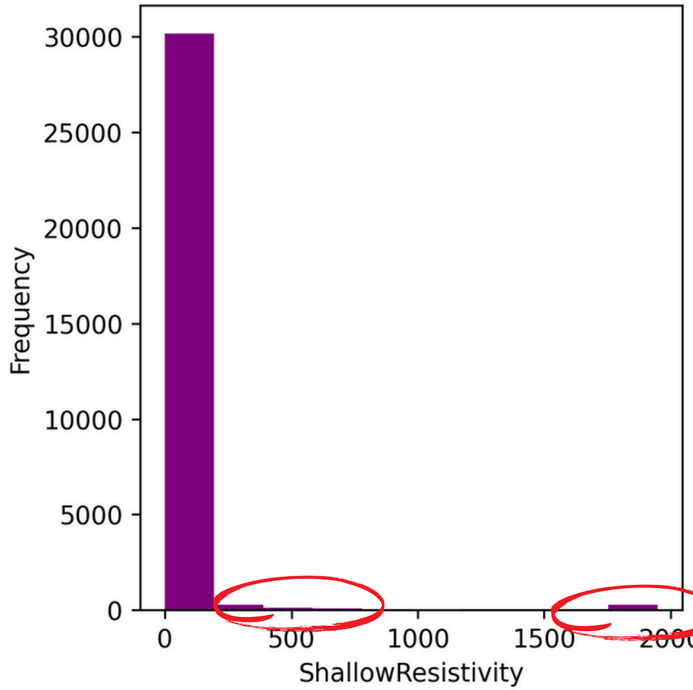
2. Quality Control

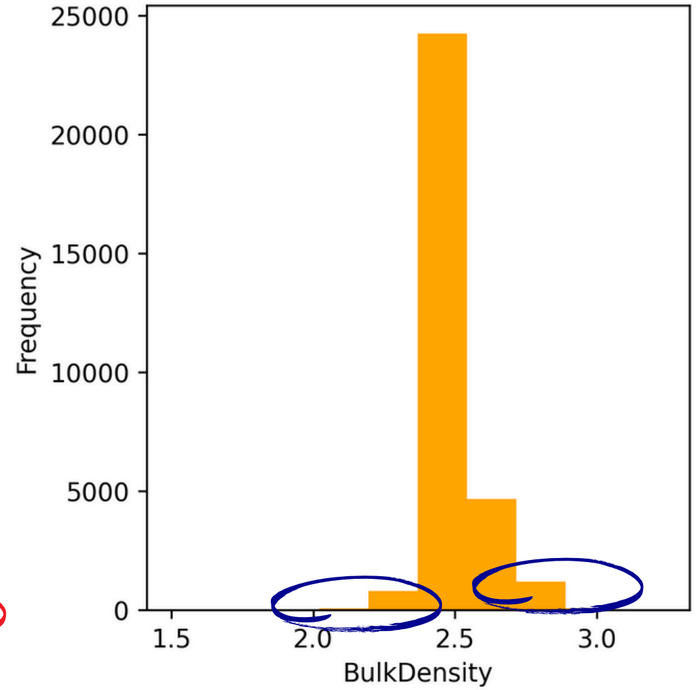




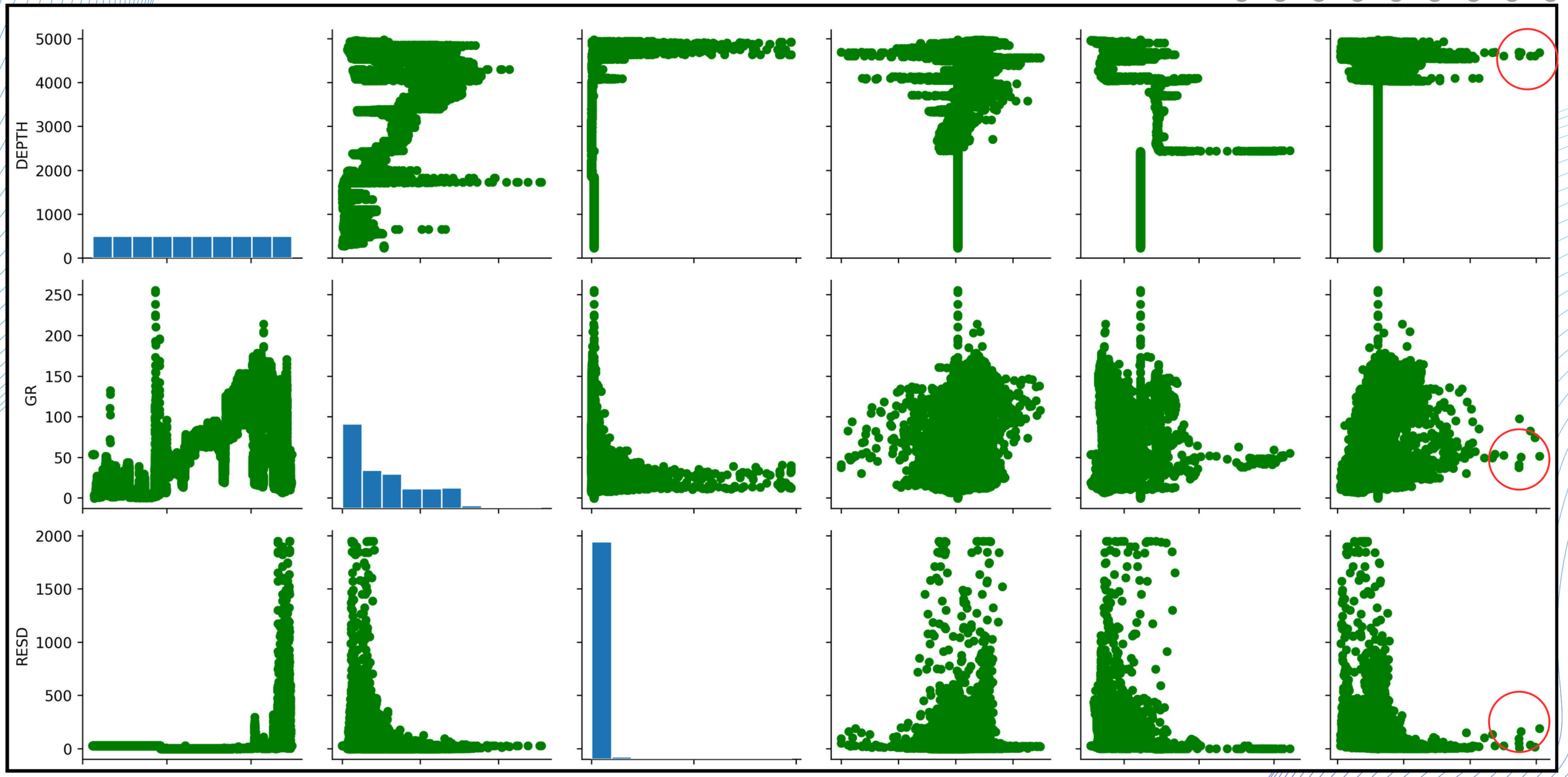




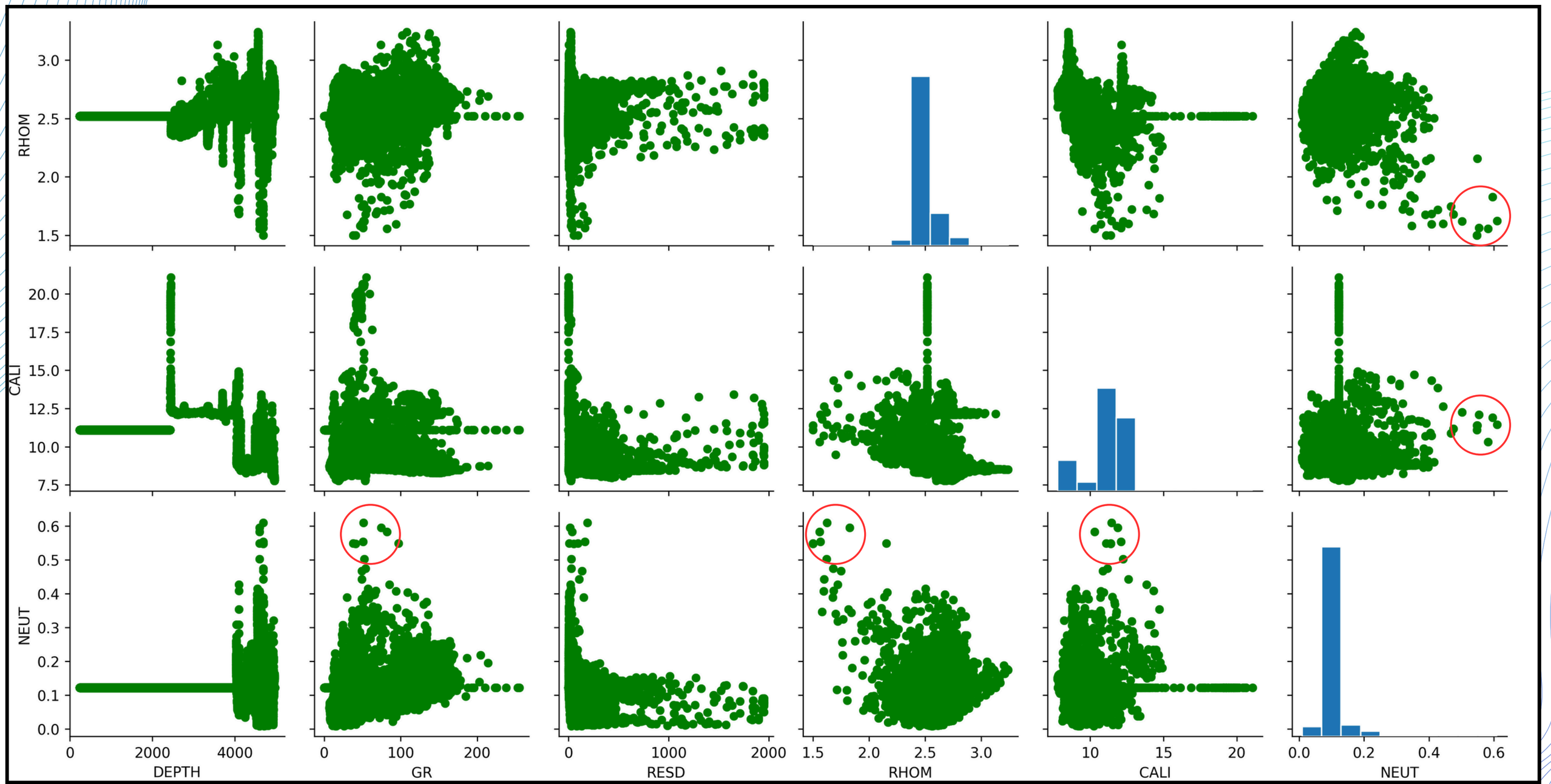




Quality Control:

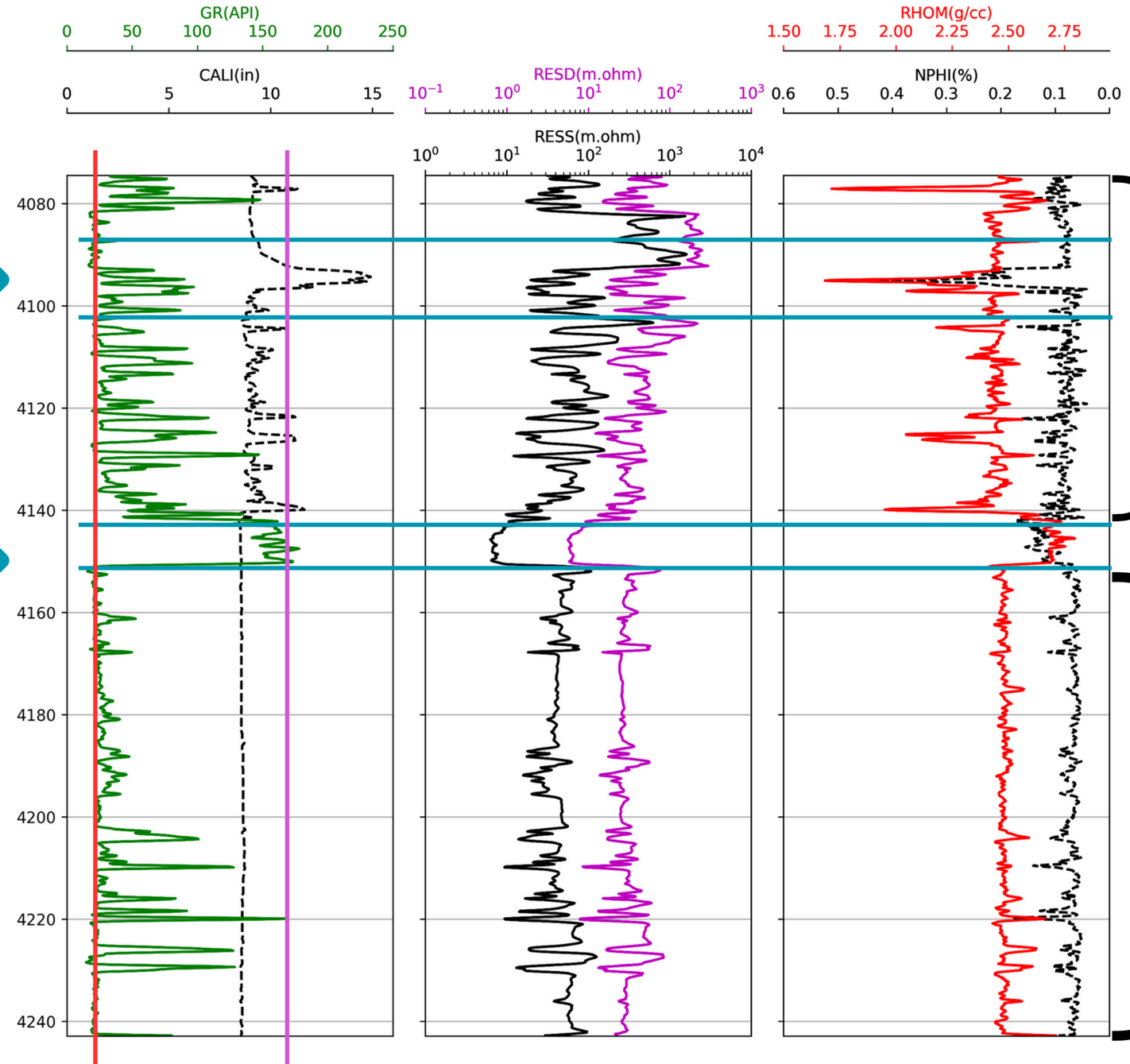


Quality Control:



2. Quality Control Of Wireline logs

Triple combo plot for desired depth



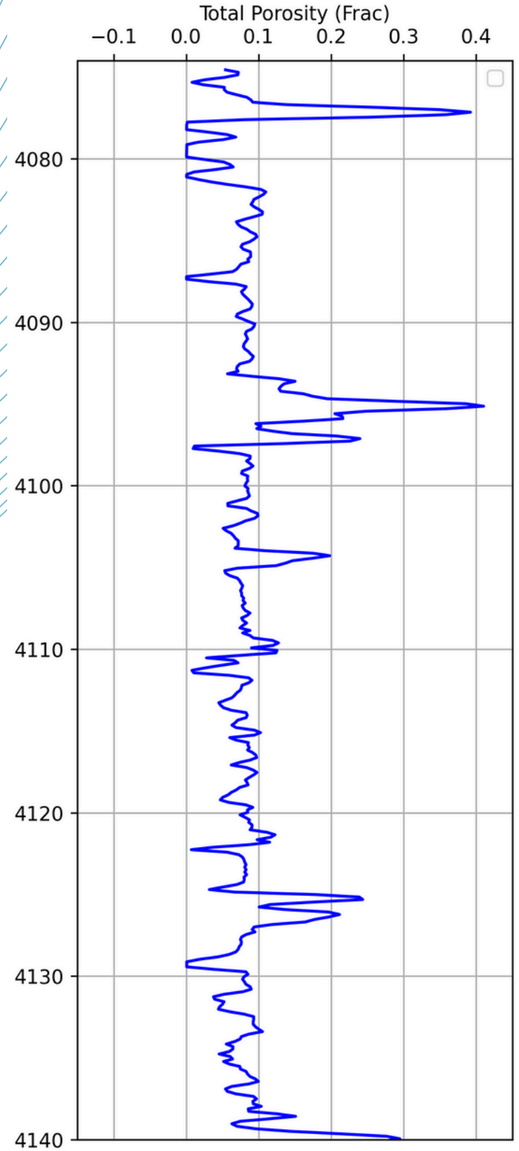
Sandstone

Shale

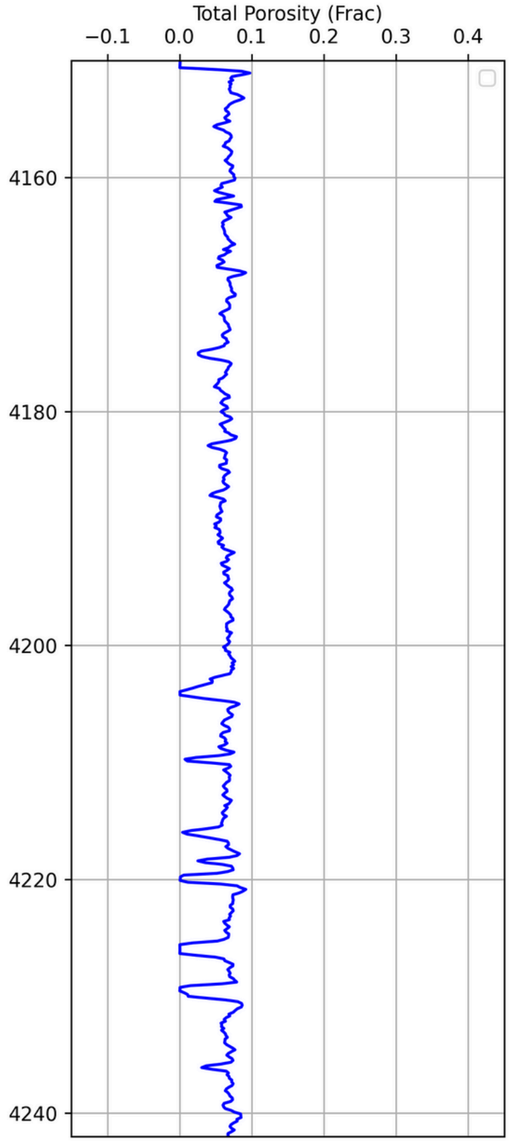
Sandstone

3. Porosity Determination

Porosity estimation



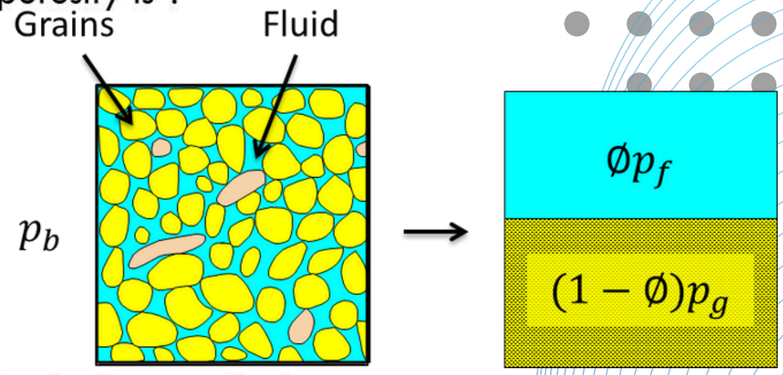
Porosity estimation



DERIVE DENSITY POROSITY BY FORMULA

- The formula for calculating density porosity is :

$$\phi_{den} = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_f}$$



- Where :
  - Φ_{den} = density derived porosity
  - ρ_{ma} = matrix density (see Table)
  - ρ_b = formation bulk density (= density log reading)
  - ρ_f = fluid density
  - (1.1 salt mud, 1.0 fresh mud, and 0.7 gas)

$$\phi_{N-D} = \sqrt{\frac{\phi_N{}^2 + \phi_D{}^2}{2}}$$ For gas-bearing formation

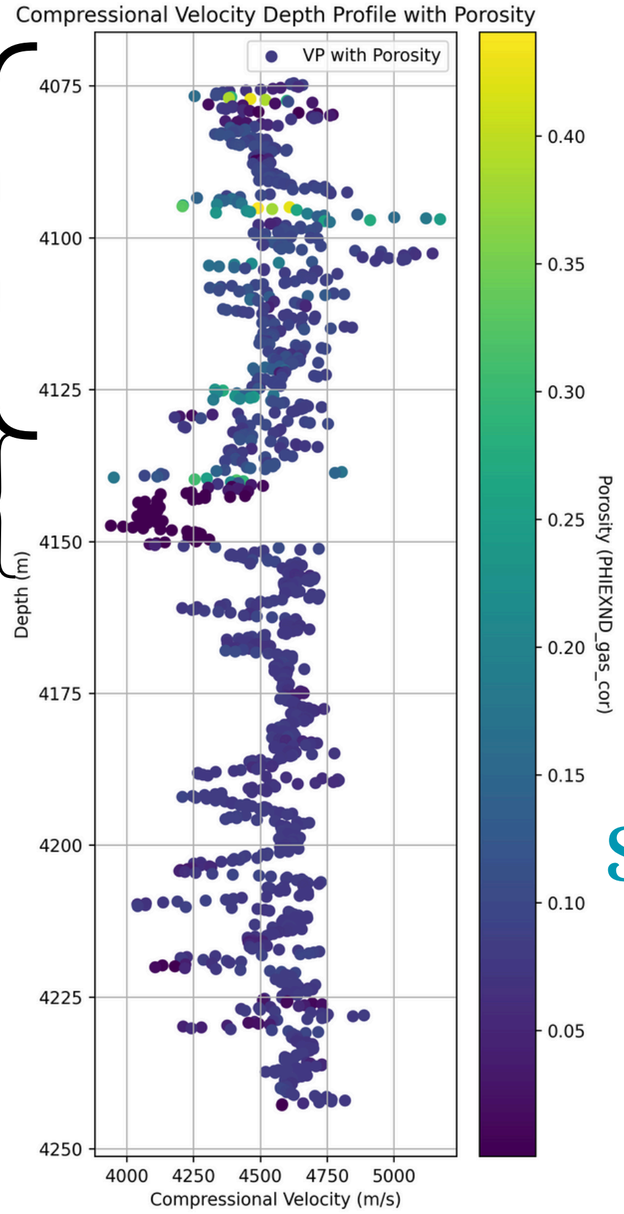
$$\phi_{N-D} = \frac{\phi_N + \phi_D}{2}$$ For oil- or water-bearing formation

4. Velocity depth profile with porosity

Sandstone

Shale

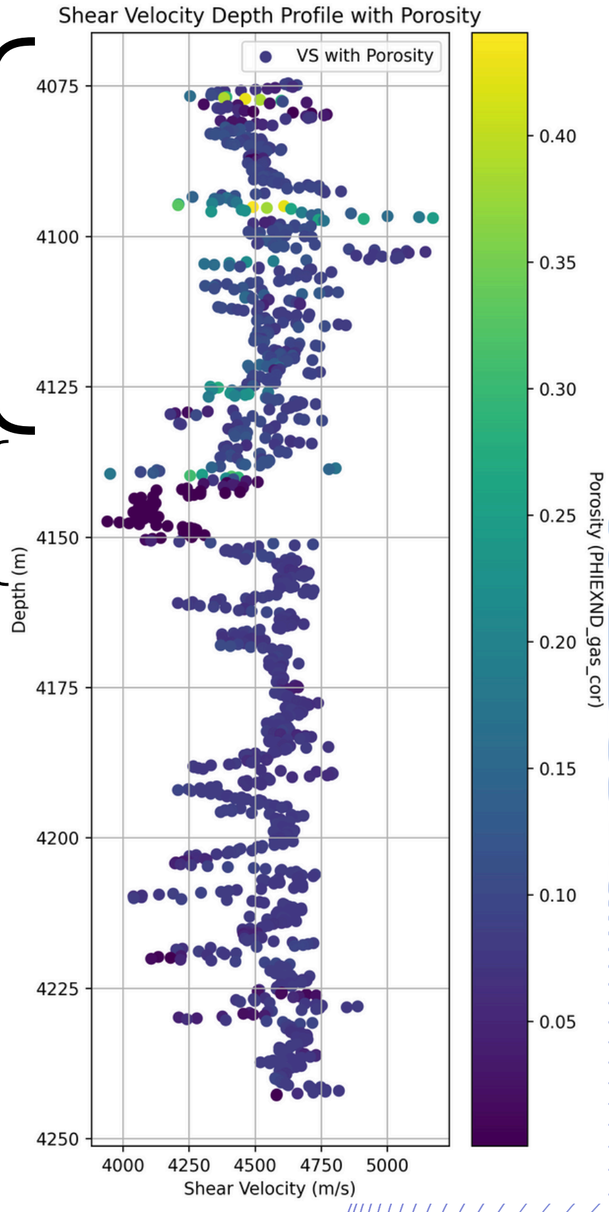
Sandstone



Sandstone

Shale

Sandstone



5. Water Saturation Sw with Archie's Method

Empirical constant (usually near unity)

Resistivity of formation water, Ω-m

$$S_w = \sqrt[n]{\frac{a\,R_w}{\phi^m\,R_t}}$$

Water saturation, fraction

Saturation exponent (also usually near 2)

Cementation exponent (usually near 2)

Porosity, fraction

Resistivity of uninvaded formation, Ω-m

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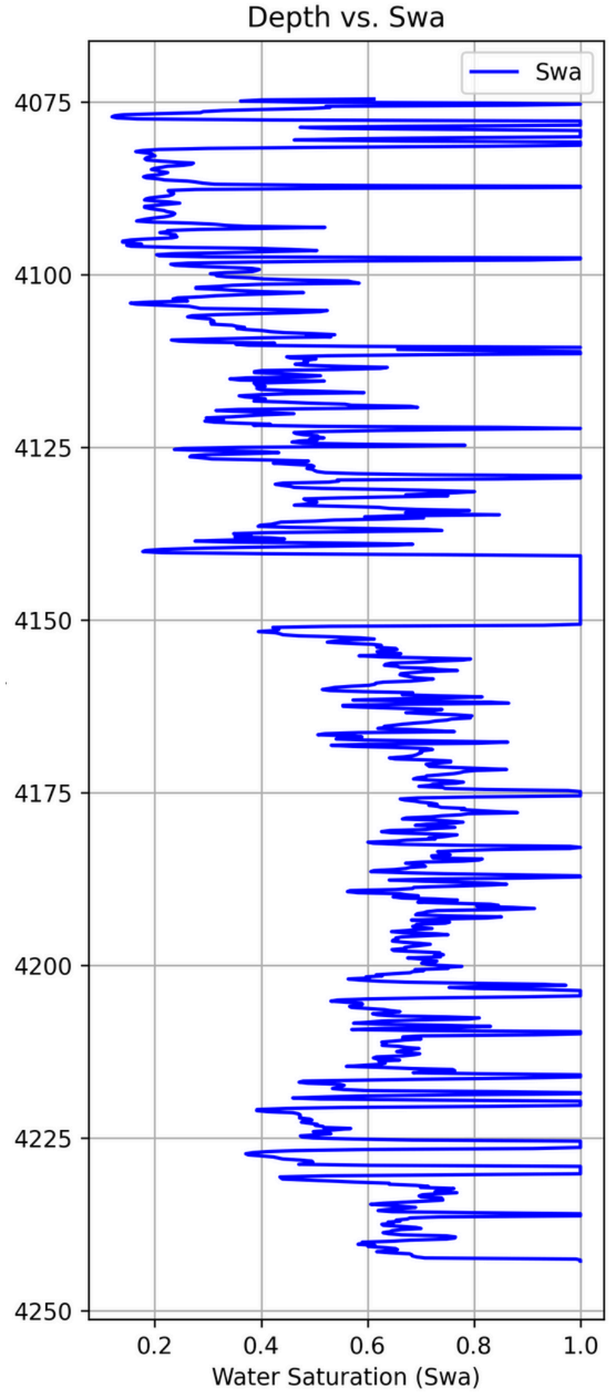
$$n = 2,\ m = 2,\ a = 1$$



Gamma ray index (Volume of shale)

here Index of GR = Volume of the Shale

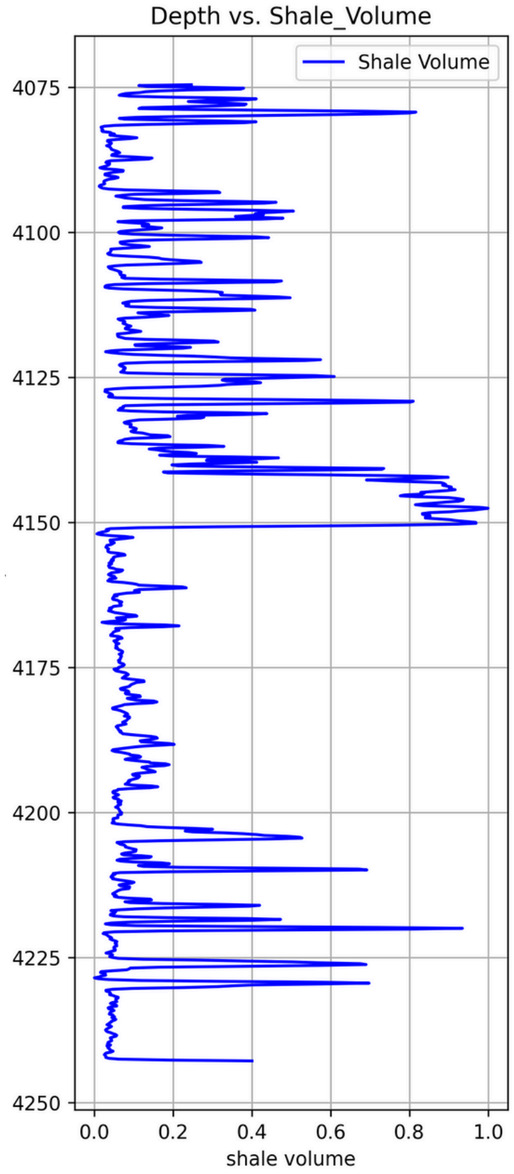
$$I_{GR} = \frac{GR_{log} - GR_{min}}{GR_{max} - GR_{min}}$$

Where: I_{GR} = gamma ray index

GR_{log} = gamma ray leading of formation

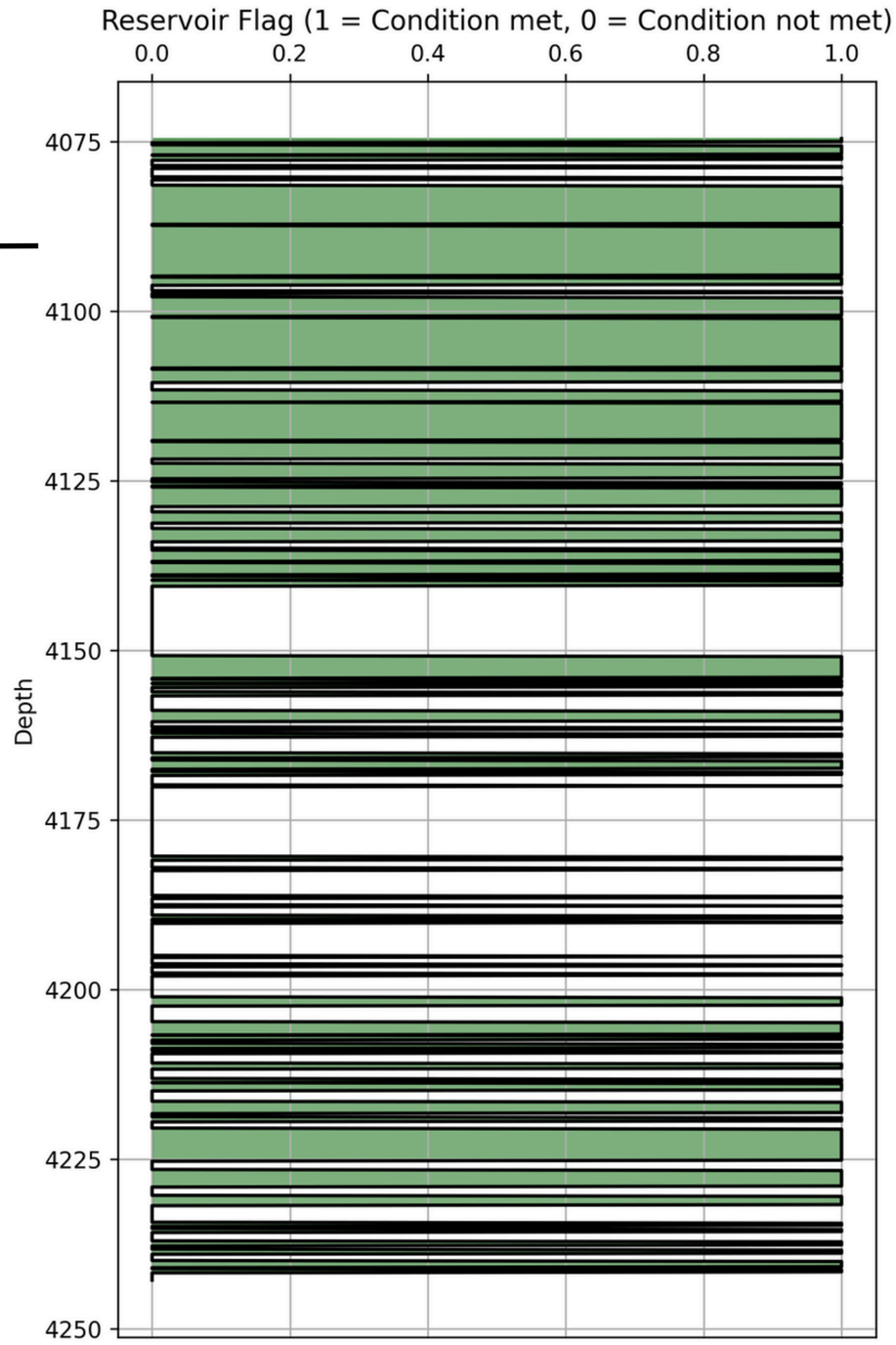
GR_{min} = minimum gamma ray (clean sand)

GR_{max} = maximum gamma ray (shale)



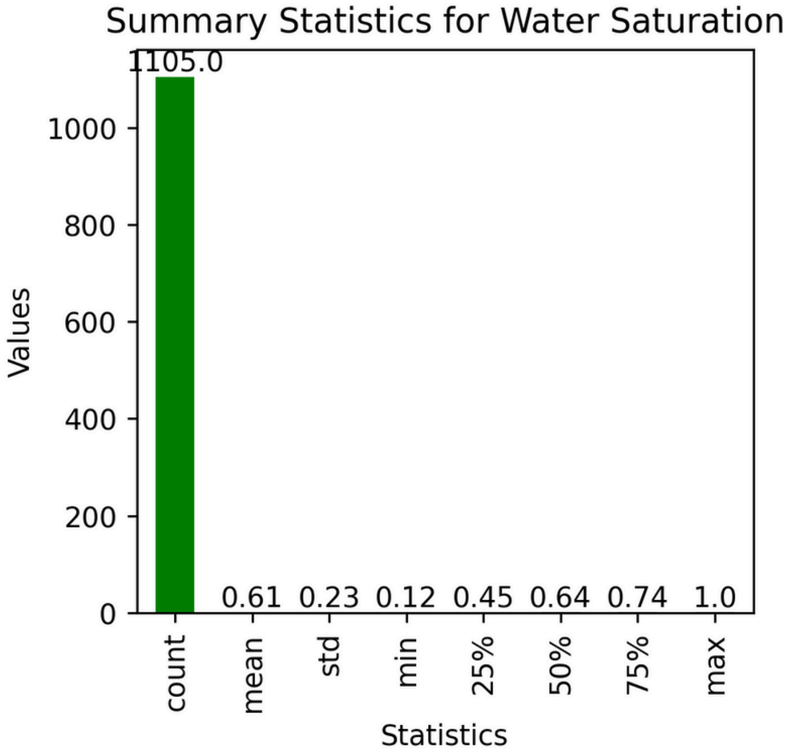
6. Reservoir Flag (Vsh <= 0.4 and Sw <= 0.65).

- Black lines represents the boundary of the reservoir zone
- Green color represents the area of the reservoir zone
- White color represents no reservoir zone

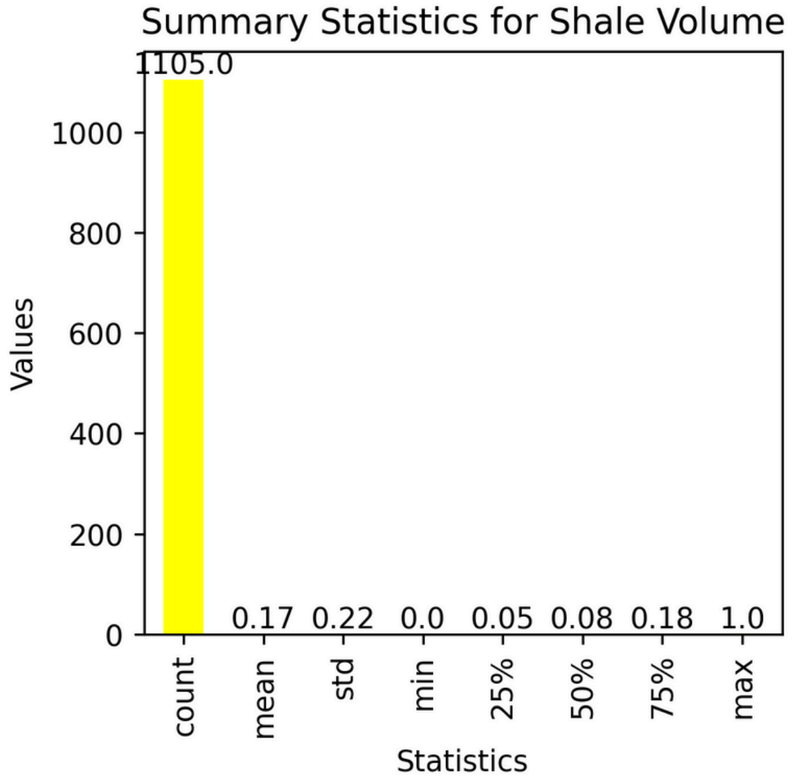


7. Statistical Analysis of Reservoir characterization

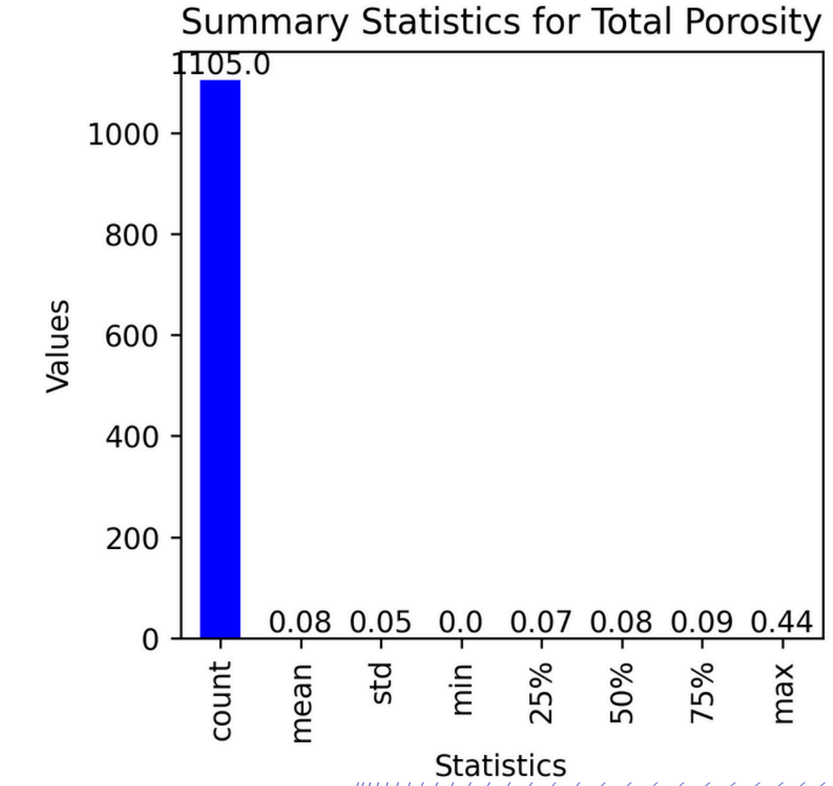
count	1105.000000
mean	0.610805
std	0.232056
min	0.119801
25%	0.446180
50%	0.638424
75%	0.741367
max	1.000000



count	1105.000000
mean	0.172863
std	0.215750
min	0.000000
25%	0.050583
50%	0.078495
75%	0.181159
max	1.000000



count	1105.000000
mean	0.083629
std	0.046050
min	0.000636
25%	0.072537
50%	0.079927
75%	0.091606
max	0.440651



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Thank you!