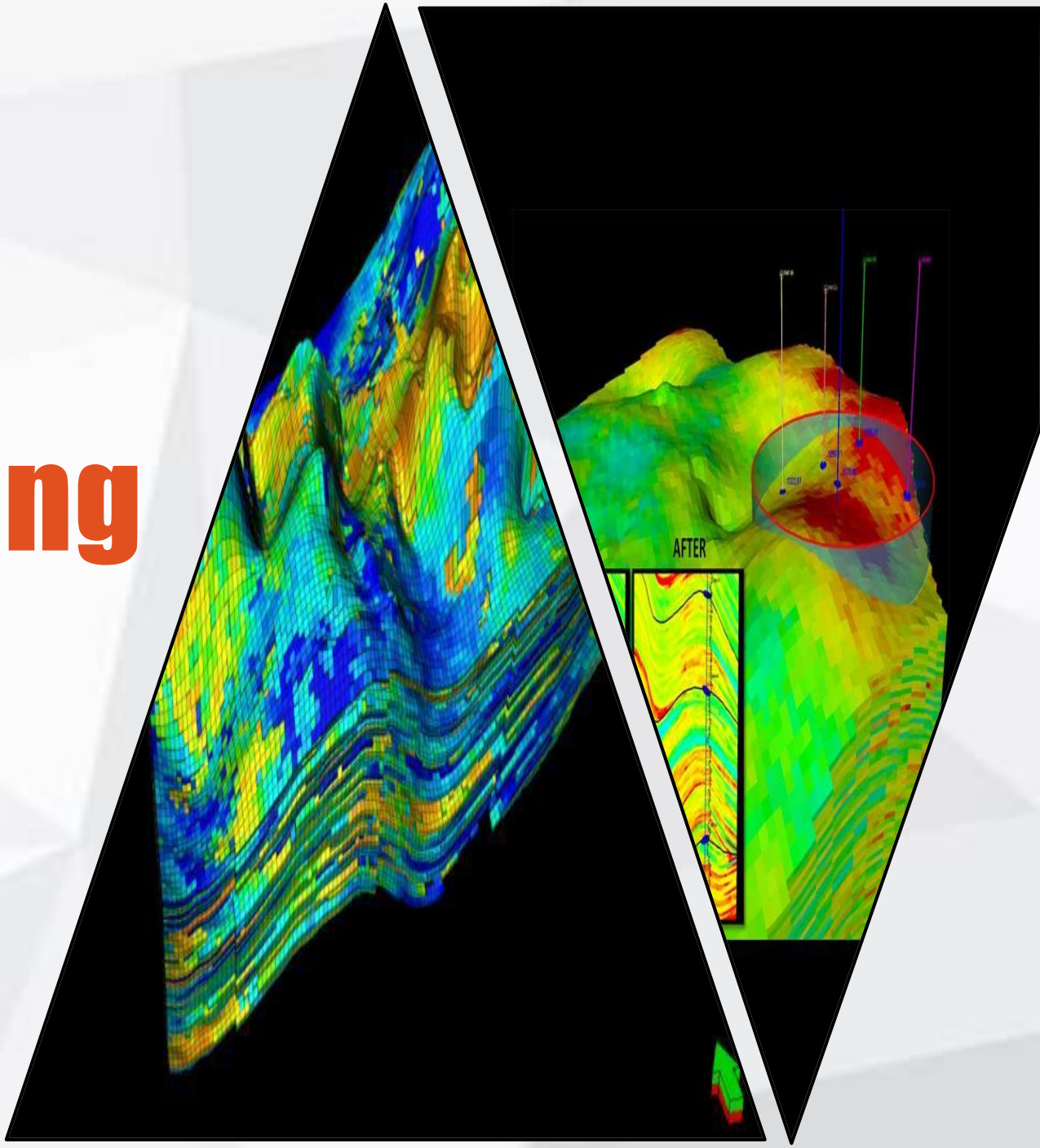
Reservoir Modelling



Petroleum & Mining Engineering Collage

Forth Year

Dr. Maha Muneeb

Property Model

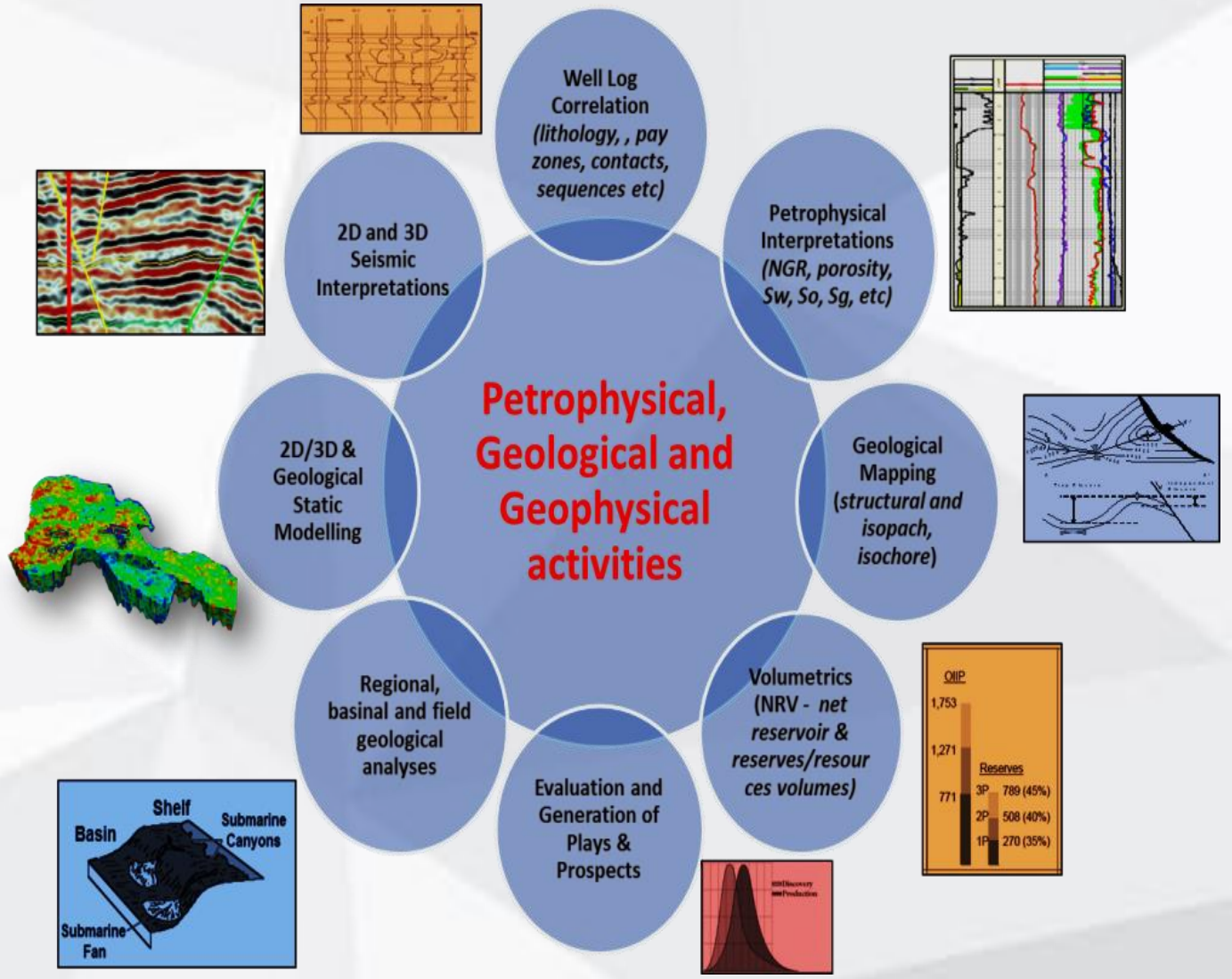
Petrophysical properties such as porosity and permeability are modeled within each facies and reservoir layer.

The main factors that control on reservoir rock properties:

There are two main sources of rock property data:

- Well Logs
- Cores

Successful property modelling depends on the analysis *of sufficient representative data and is best done by a geologist and a petrophysicist* together.



The main petrophysical properties do we want to model. (Fluid and Rocks)

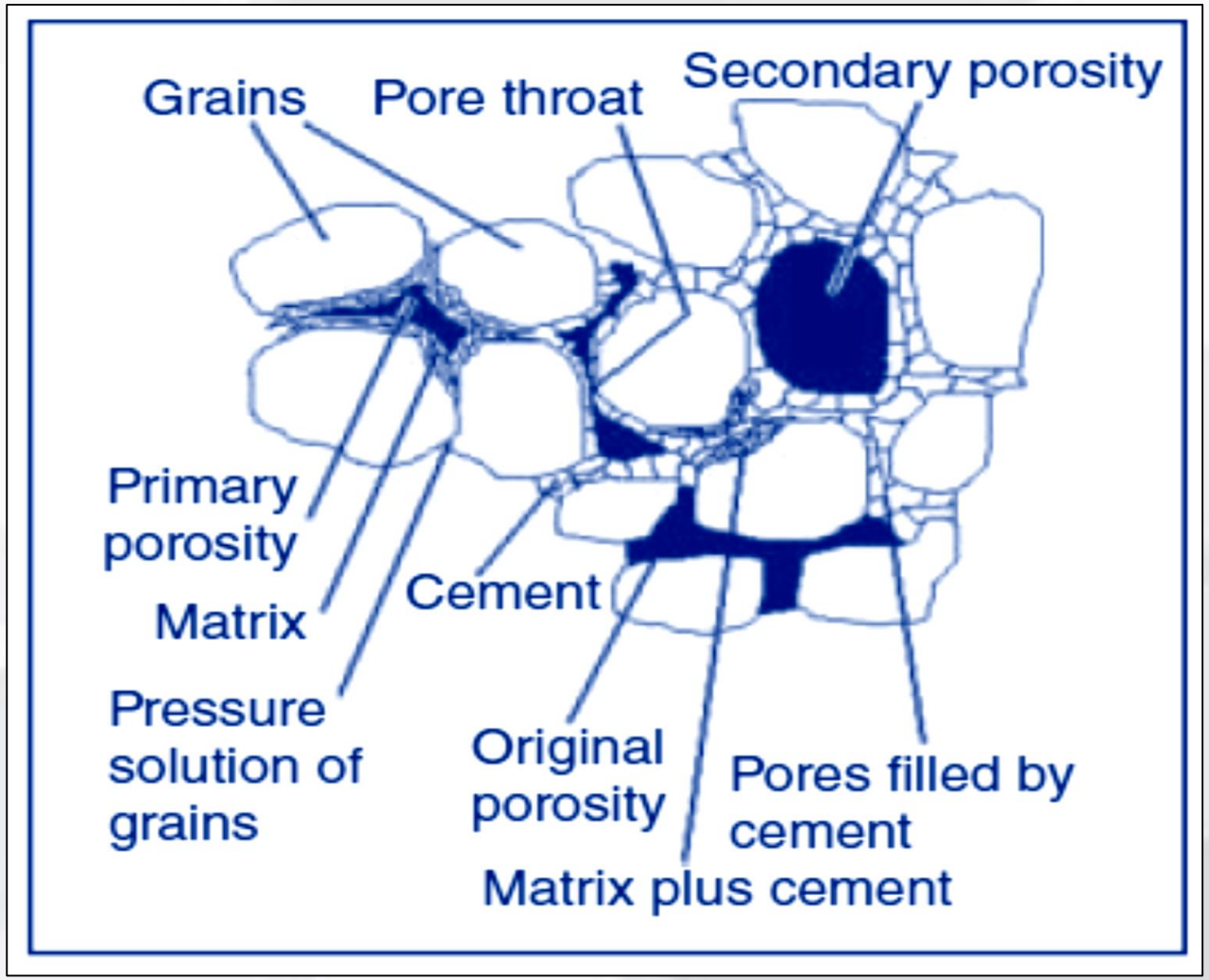
- Porosity (ϕ)
- Permeability (k) the essential parameters in the flow equation (Darcy's law)
- Formation bulk density (ρb)
- Sonic p-wave velocity (Vp)
- Volume fraction of shale (Vshale)
- Fracture density
- Water saturation (Sw)
- Capillary pressure
- Wettability

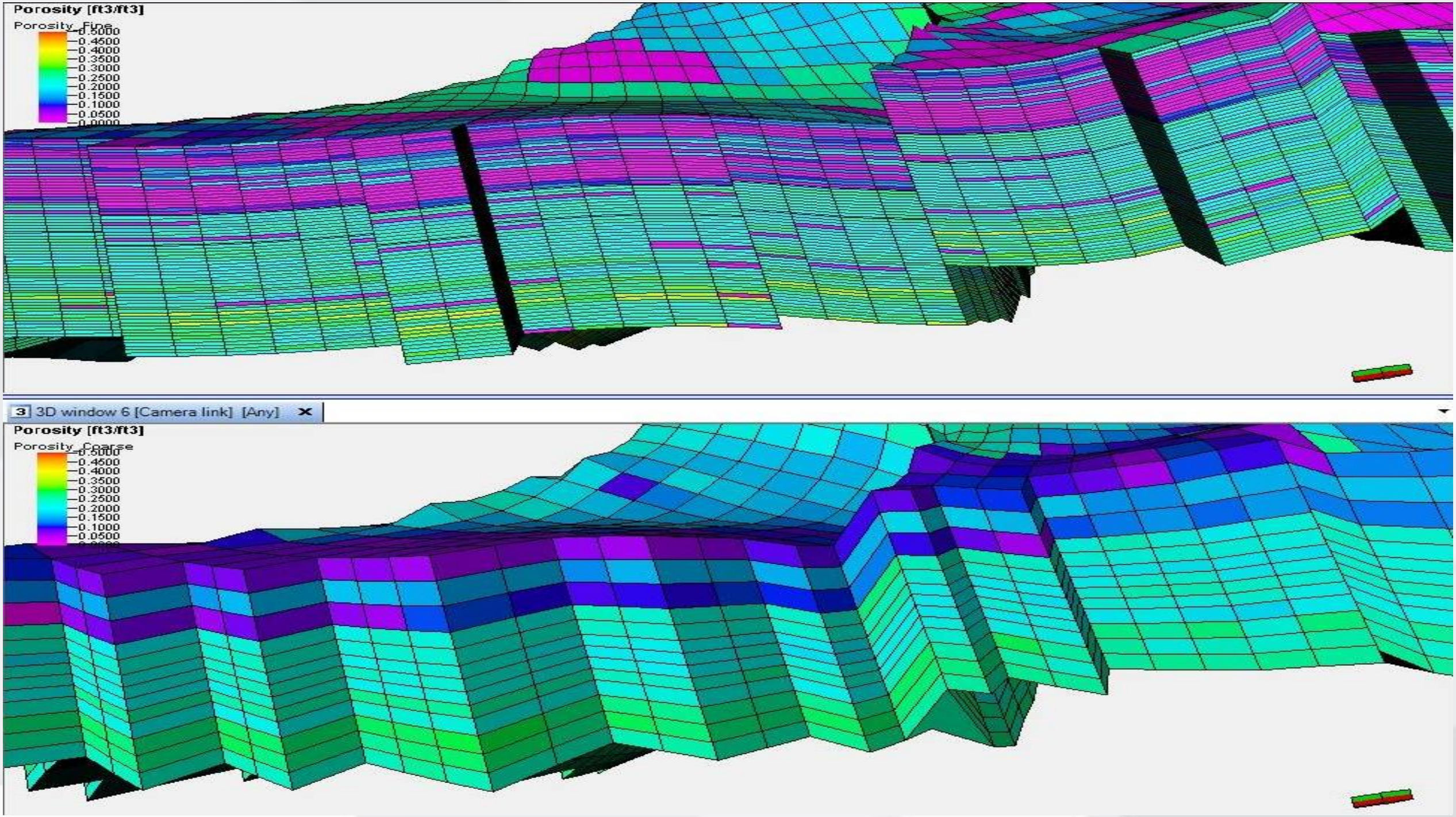
Porosity

The capacity of a rock to store fluids and estimated as the ratio of the pore volume to the bulk volume.

- Primary Porosity
- Secondary Porosity

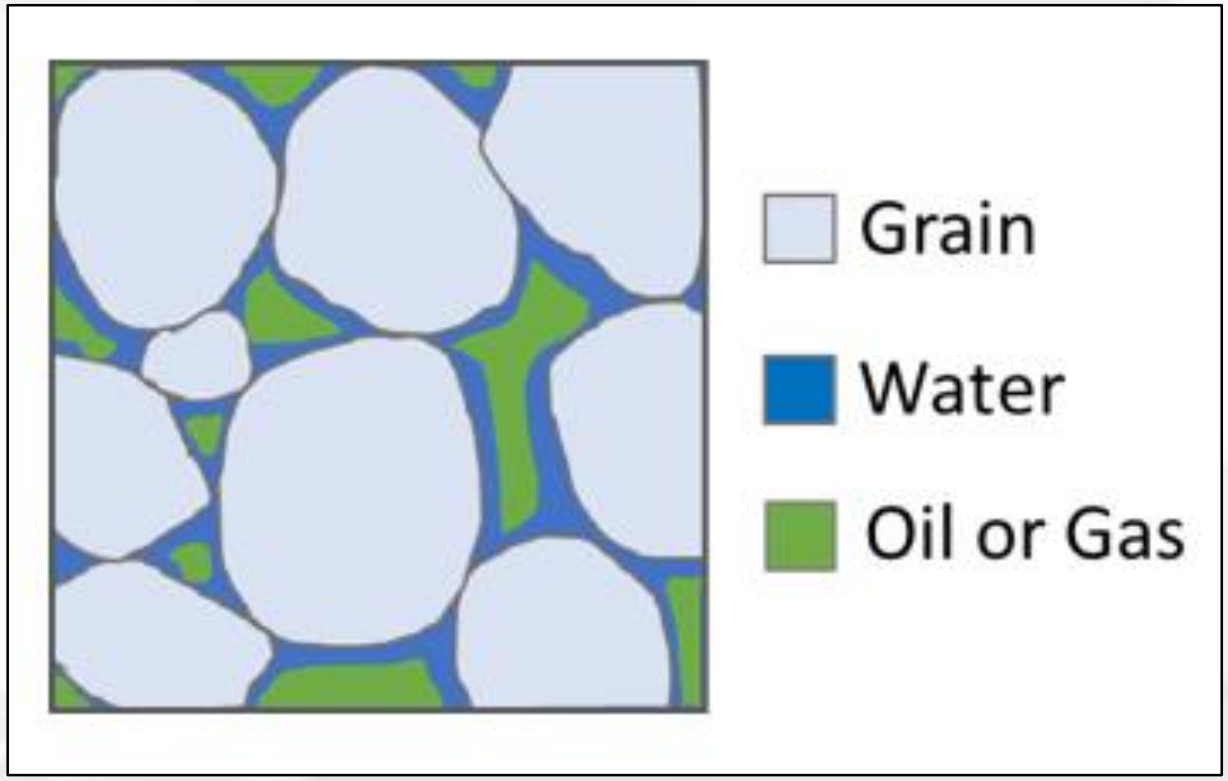
- Total Porosity
- Effective Porosity




Porosity [ft3/ft3]
Porosity_Fine
0.5000
0.4500
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
3 3D window 6 [Camera link] [Any]
Porosity [ft3/ft3]
Porosity_Coarse
0.5000
0.4500
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500

Water Saturation (S_w)

is the proportion of total pore volume occupied by formation water; hydrocarbon saturation is derived from the relationship (S_h=1-S_w).



Logs measures both the mobile water and the clay-bound water in the pore space.

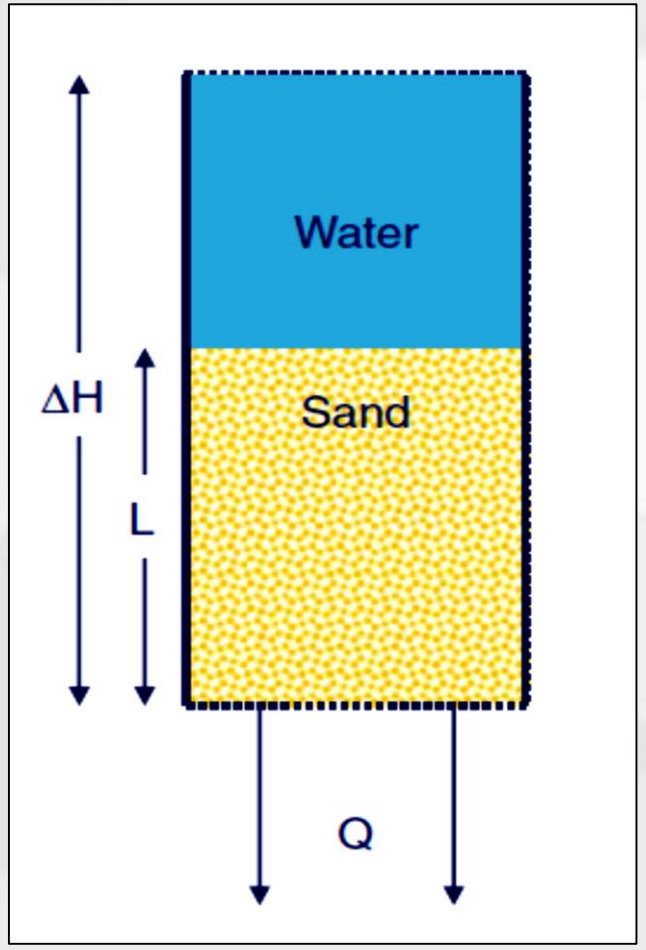
Permeability

is the measure of the capacity of a reservoir to conduct fluids or for flow to take place between the reservoir and wellbore.

Core, log and production test are the main resources to estimate the permeability.

The basic permeability equation is based on the observations and field experience of Henri Darcy

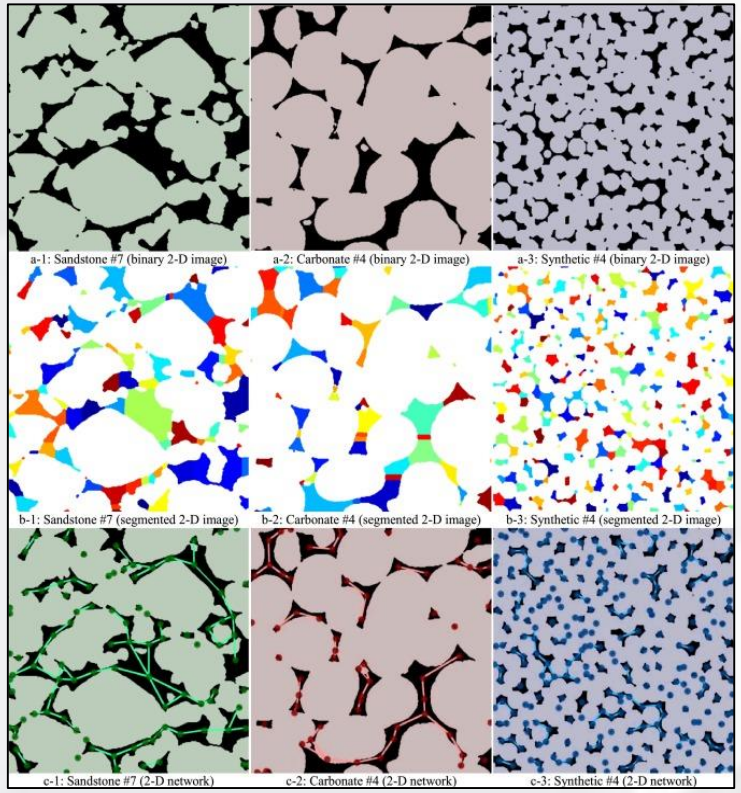
$$Q = KA(\Delta H/L)$$

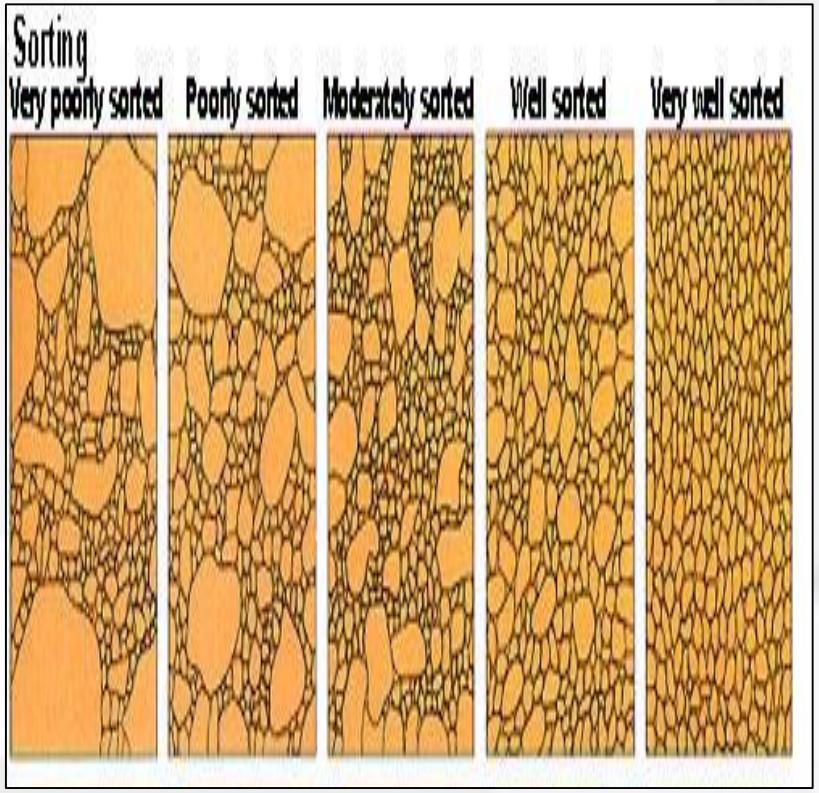


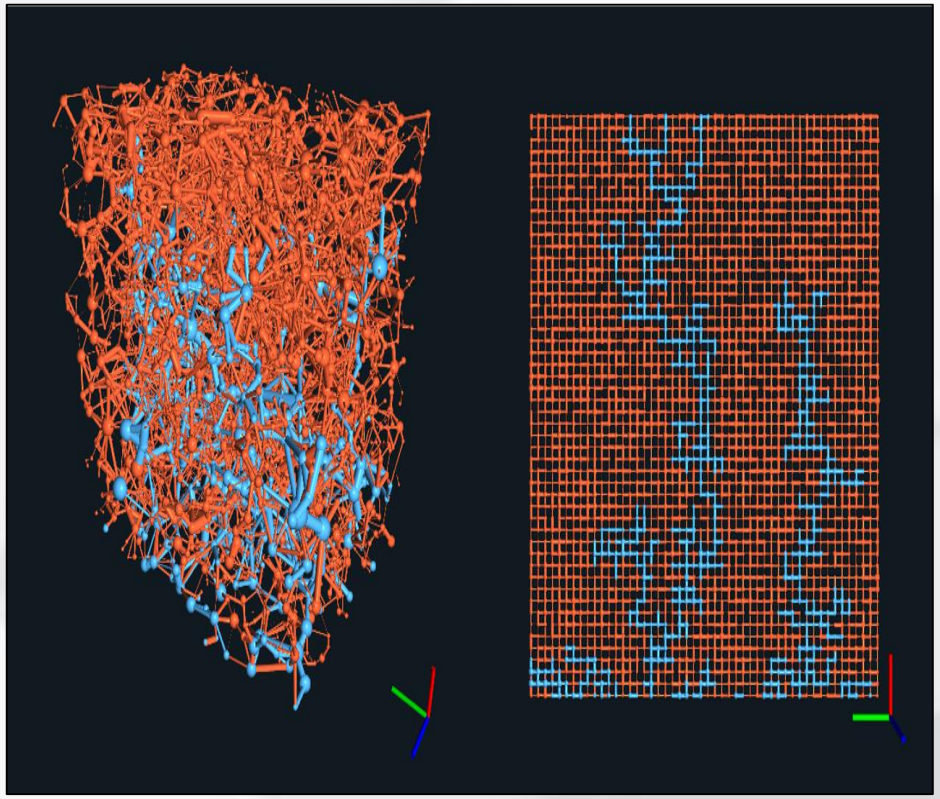
Where:

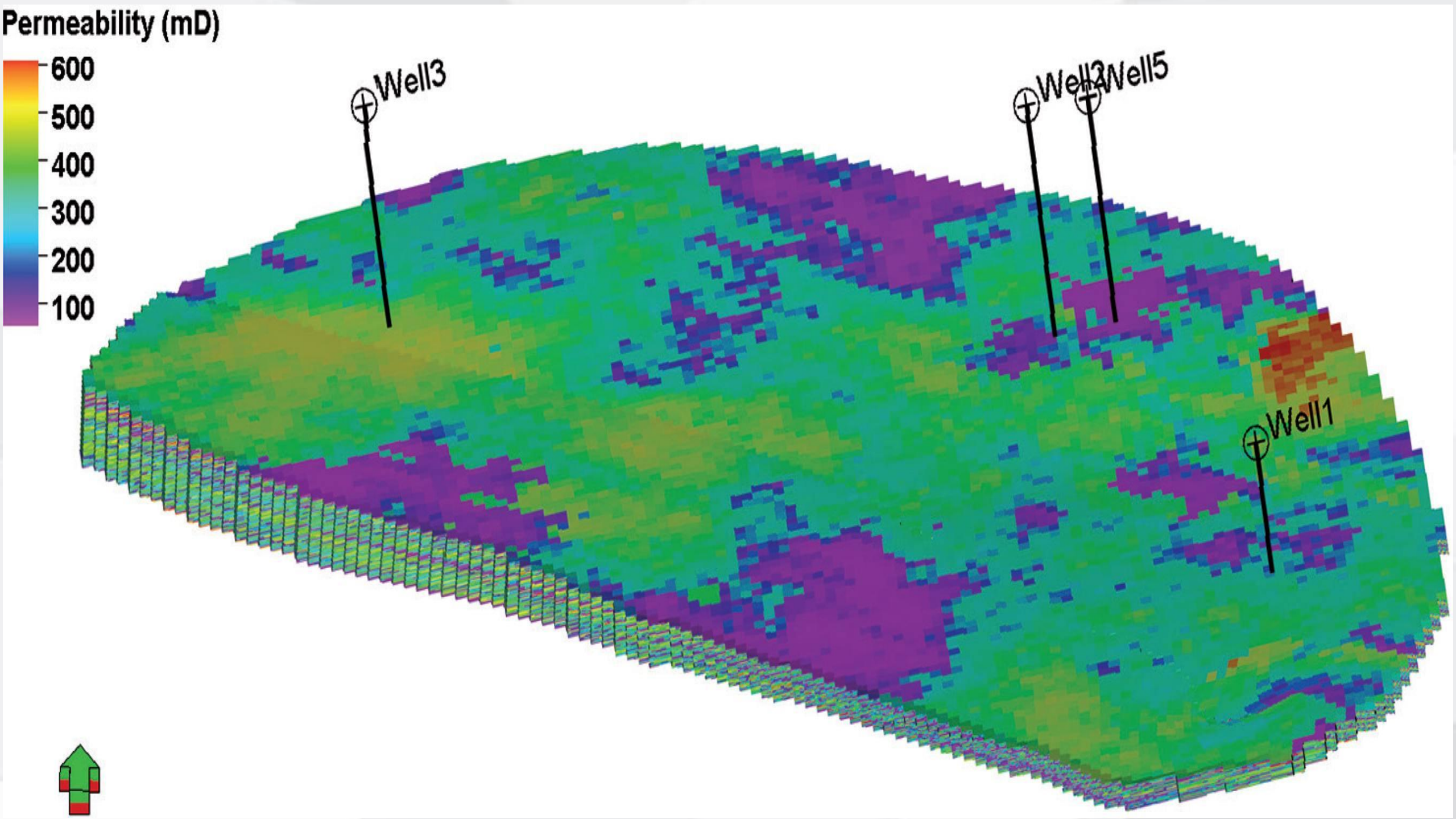
Q = volume flux of water, K = permeability, A = cross sectional area, ΔH= height of water column, L = length of sand column.

- At the microscopic or plug scale, permeability is a function ***of pore network***
- Large or small pore throats and whether the connecting pathways are straight or tortuous, a function of ***grain size and sorting***.



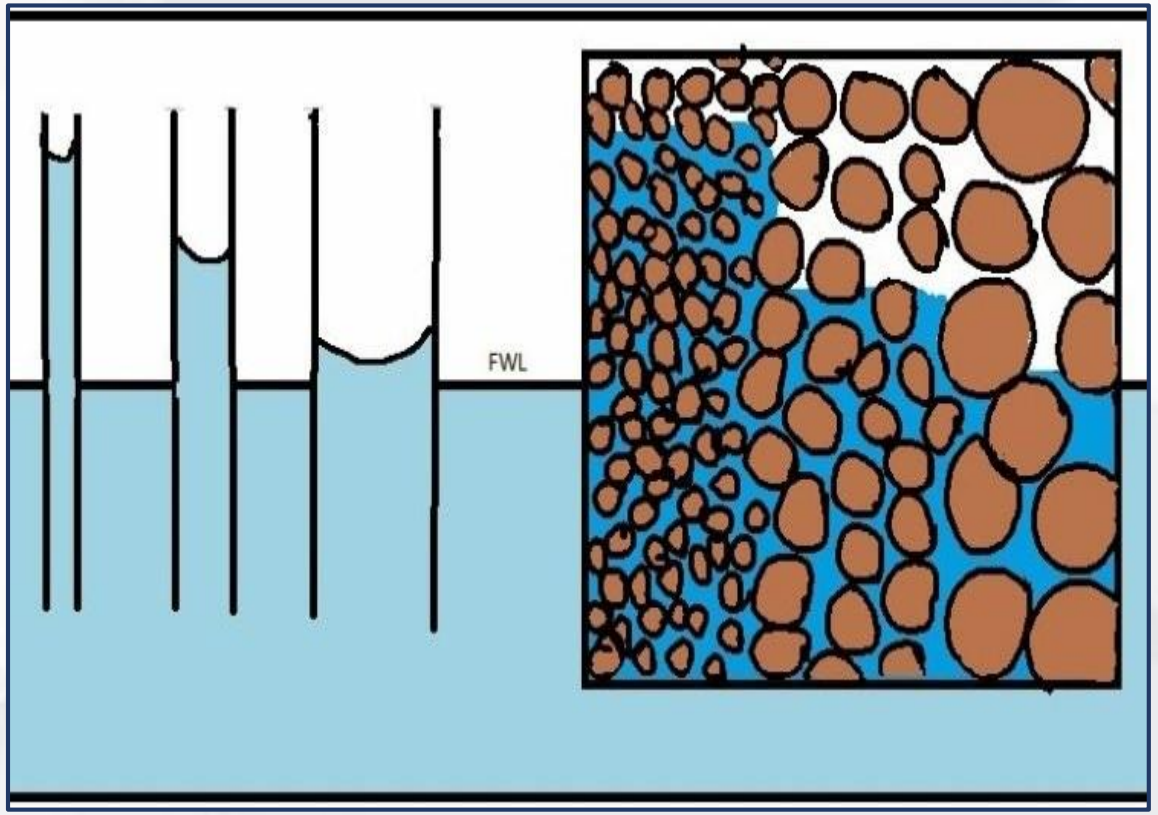





Permeability (mD)
600
500
400
300
200
100
Well3
Well2
Well4
Well5
Well1

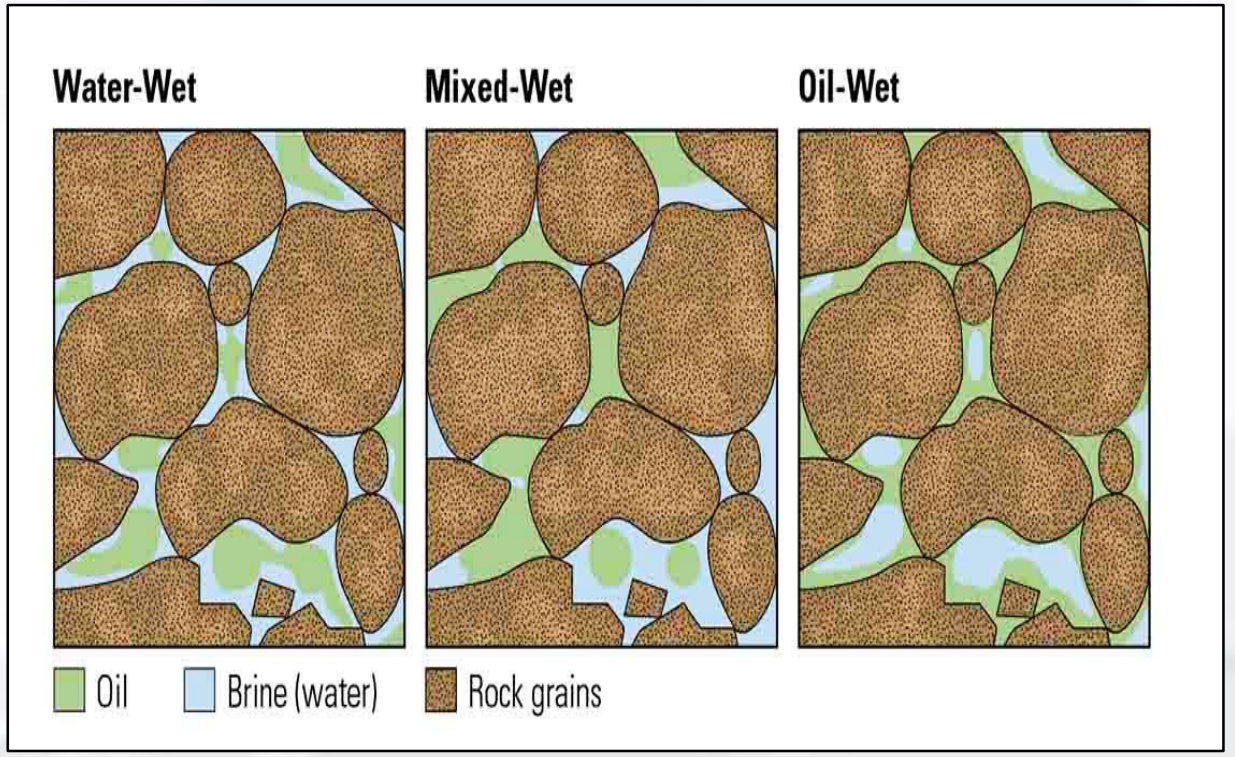
Capillary Pressure

Capillary pressure occurs whenever **two immiscible fluids** occur in the pore space of a rock and is defined as the pressure difference measureable in the two phases.



Wettability

Wettability is a measure of a rock's propensity to adsorb water or oil molecules onto its surface in the presence of another immiscible fluid.

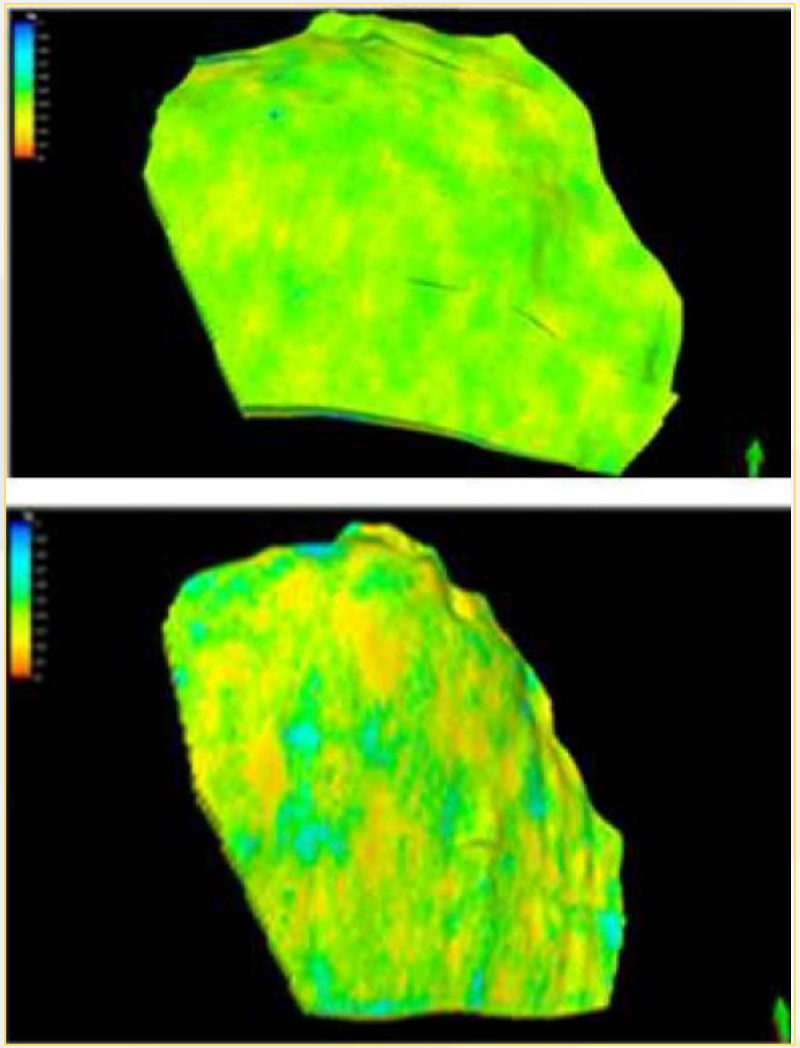


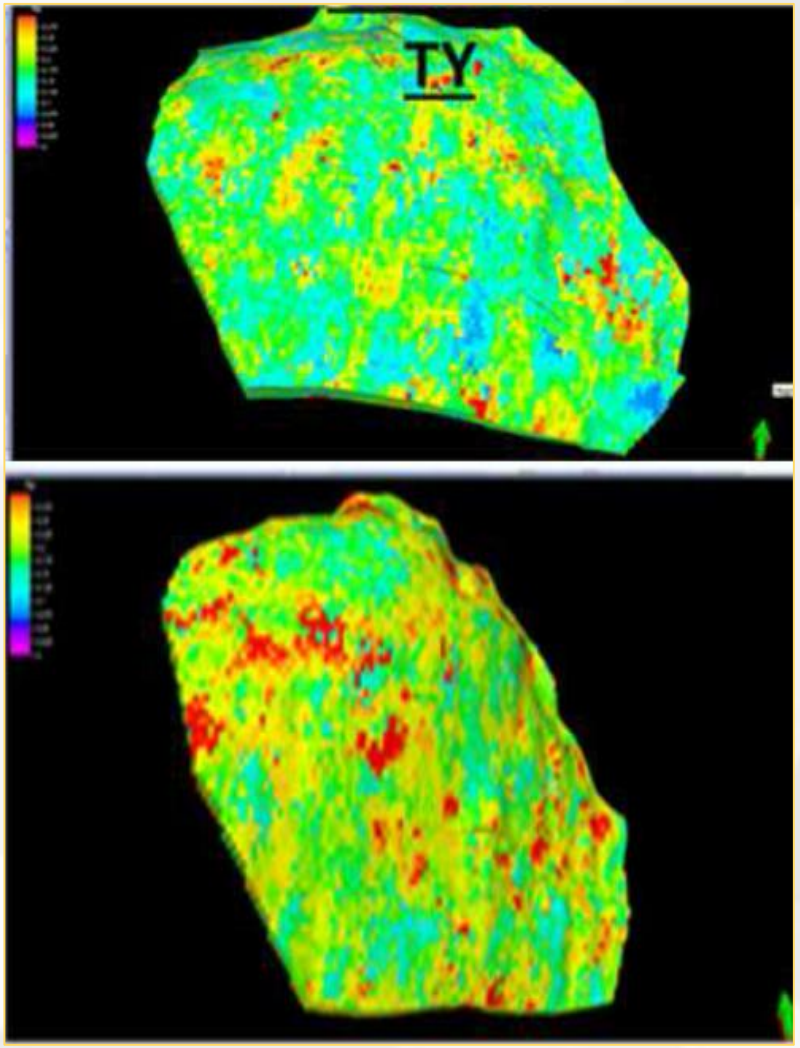
Wettability is a function of the surface tension between the solid grain and the fluid in the pores

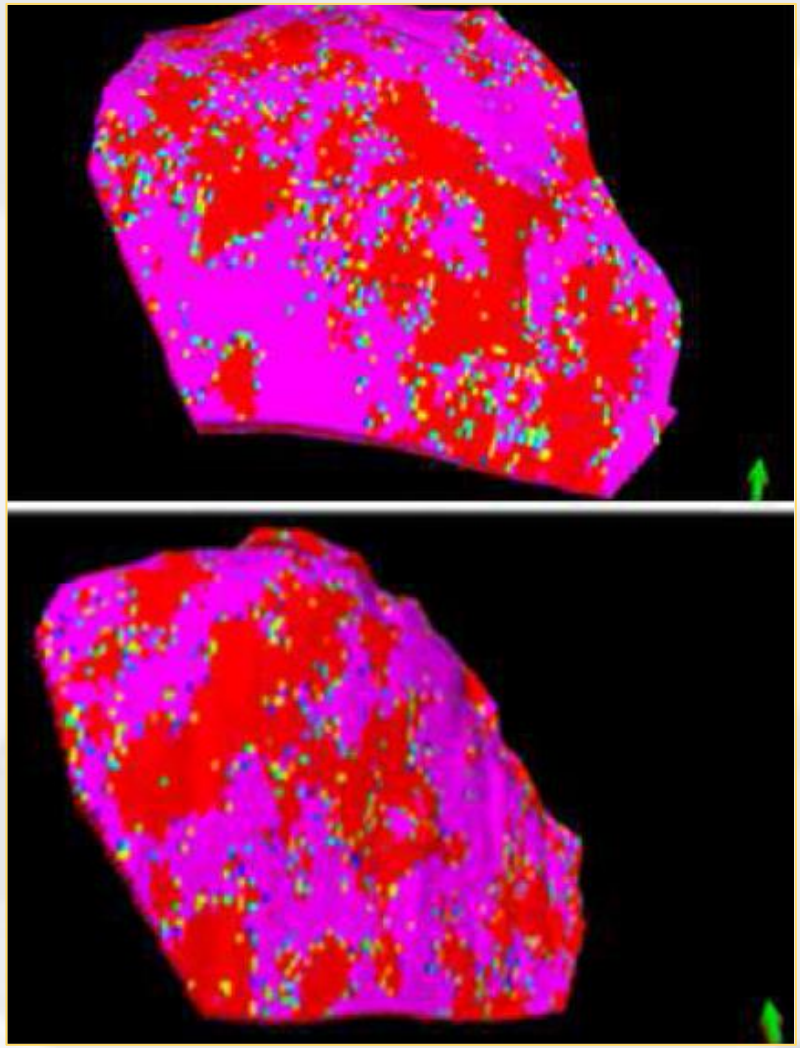
Sw

Phi

Net Gross







Property Modelling Workflow

Data screening

Data screening: Ensure that all anomalous values, data spikes or outliers have been deleted or explained

Blocking

The property data must be upscaled into the grid cells in each of the wells to determine the difference in the levels of heterogeneity

Review

the property data statistics with respect to the facies scheme to ensure that the sufficient level of detail has been captured.

understand the spatial relationships

by looking for vertical or lateral trends by an experimental variogram.

Decision

Decide which property modelling method is appropriate for your data

Property Modelling Methods

There are several ways to model reservoir properties. All models will have different outcomes when calculating volumes, well planning or dynamic simulation.

1

Deterministic Methods

In cases where a simple or quick model is required

- Constant value
- 2D maps
- Interpolation

2

Statistical Methods

Geostatistical property modelling allows more control on the spatial statistics of the model and also allows for smaller scale heterogeneity to be captured.

- Kriging
- Simulation