SELF POTENTIAL LOG(SP)

➢ INTRODUCTION:

Self Potential (SP) geophysical surveys measure the potential difference between any two points on the ground produced by the small, naturally produced currents that occur beneath the Earth surface.

OR

The SP curve is a continuous recording vs. depth of the electrical potential difference between a movable electrode in the borehole and a surface electrode. Adjacent to shales , SP readings usually define a straight line known as the shale baseline.

➢ CONDITIONS OF SP LOG:

Three conditions of sp log.

1. Porous and permeable strata bounded by impermeable layer.
2. Two different fluids.
3. Difference in salinity.

1. POROUS AND PERMEABLE STRATA BOUNDED BY IMPERMEABLE LAYER:

It means that the reservoir rocks are bounded by shales above and below the reservoir rocks. During drill we inject the detector and recorder that detect and record the variation between shale and reservoir rocks.

2. Two different fluids:

Two different fluid means oil , gas and brine water blow the surface.

3. DIFFERENCE IN SALINITY:

salinity means amount of salt . Difference in salinity means how much amount of salt dissolve in water . For that we use fresh water which tell us the difference of salt.

DIFFUSION POTENTIAL:

Diffusion:

The process by which flow of fluid from high concentration to low concentration are called diffusion.

In bore hole water move from high concentration to low concentration.

If fluid is more in reservoir (means Na) then chlorine ion, as a result fluid collect the negative ions it means that the salinity of mud filtrate is less then formation fluid. And the curve is different.

SHALE POTENTIAL:

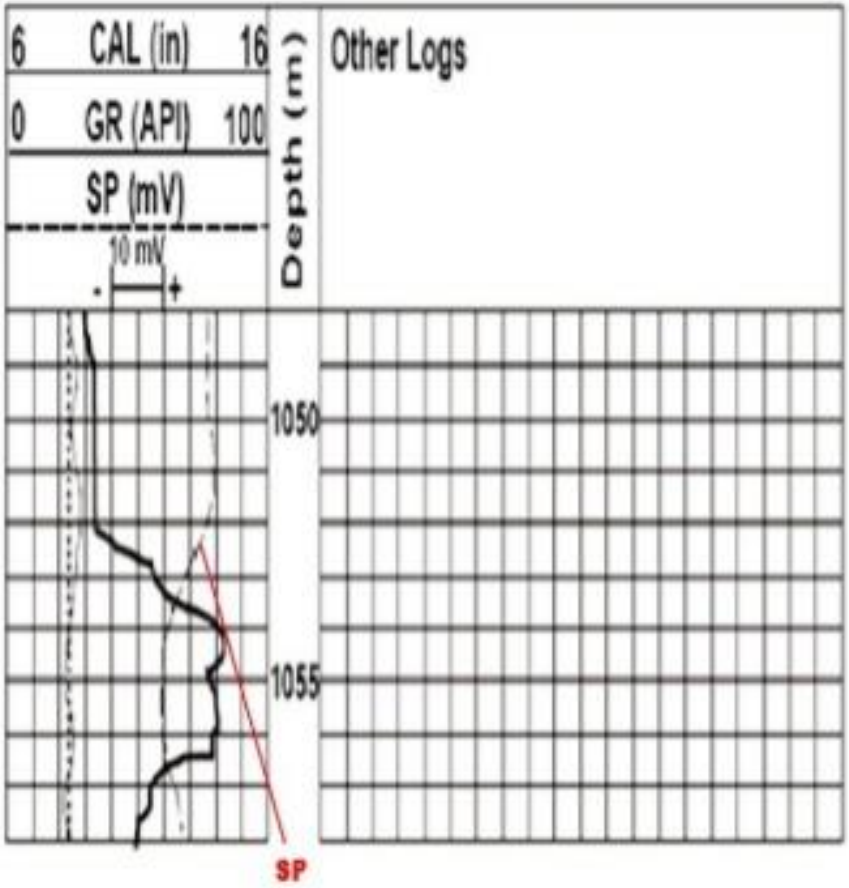
Shale itself having negative charge it collect positive charge at shale so mud filtrate has high salinity then formation fluid.

In borehole salinity is mixture of Na and Cl ions . In this case sodium ion is slow moving ion and chlorine ion is fast moving ion and react with sodium pon and form sodium chloride, It means salinity of mud filtrate is more then formation fluid, because it collect the positive ions.

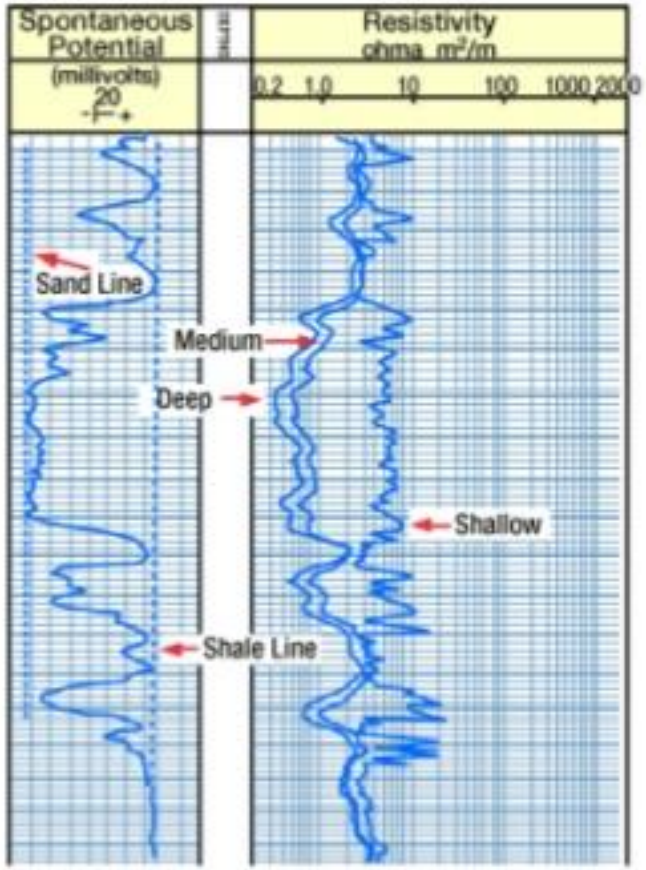
Log Presentation

SP is presented in :

- Track 1
- SP currents measured in milli volts.
- Scale is in +ve or –ve mili volts
- -ve deflection to left and +ve to the right
- It is usually run with Gamma ray or Caliper Log

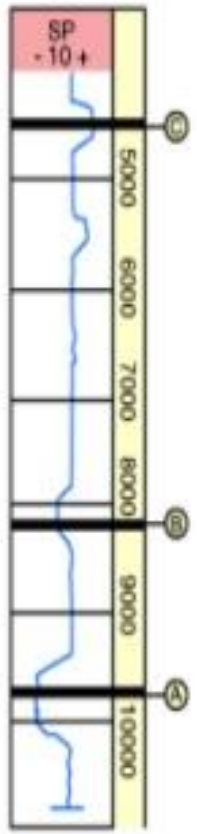


Log Presentation



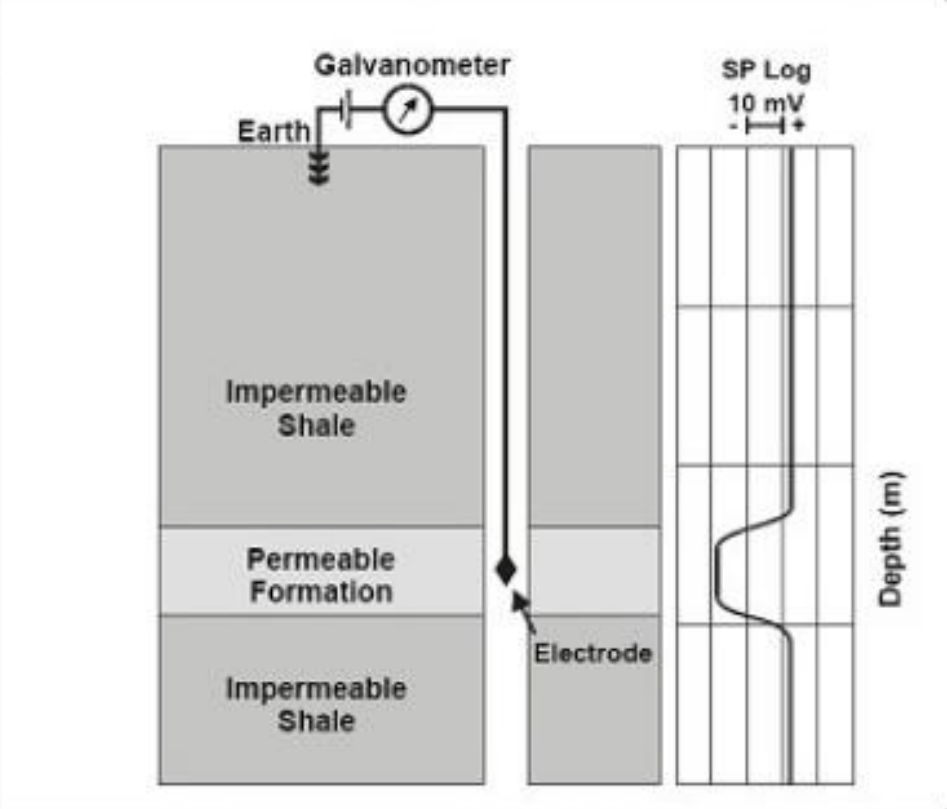
How to read a log

- In sand A, Rw is less than Rmf; i.e., formation water is saltier than the mud filtrate.
- In sand B, the SP deflection is less than in sand A, indicating a fresher formation water.
- In sand C, the SP is reversed, indicating formation water that is fresher than the mud filtrate (Rw > Rmf).
- We may guess that, at about 7000 ft, Rmf and Rw are equal.



Tools

- Electrodes
- A galvanometer
- Small 1.5 V battery



Calibration

- A small battery and a potentiometer is placed in series between the two electrodes.
- The logging engineer can adjust the potentiometer so that the SP appears in track 1.
- Remove all extraneous potentials to the membrane potential, the SP needs to be normalised in a computing centre so that there is no potential (SP=0.0MV) opposite shale beds

Application

Two principal uses of Sp Logs

QUANTITATIVE USES

- Formation Water Resistivity (Rw)determination
- Shale Volume Indicator

QUALITATIVE USES

- Detecting permeable beds
- Correlation from well to well
- Facies

APPLICATIONS OF SP LOG:

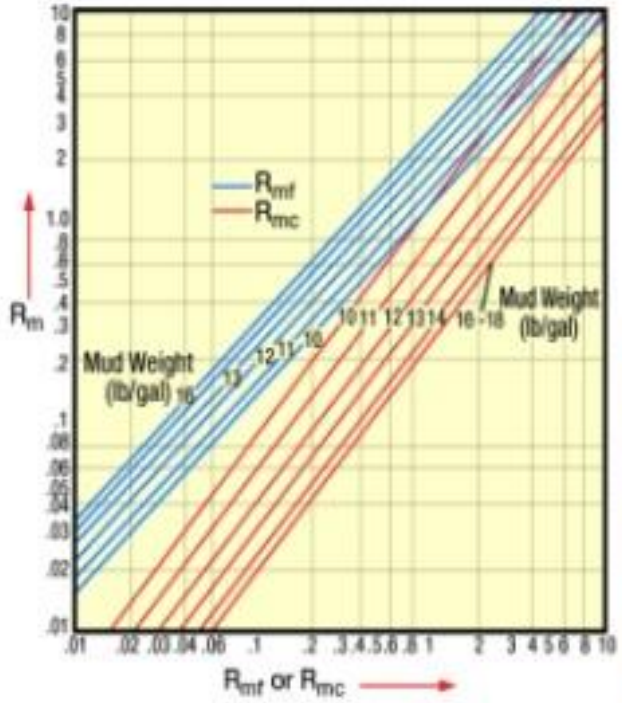
- It is used to find the oil and gas.
- It is used to find the volume of shales.
- Finding leaks in canal embankments.
- Identifying seepage in dams and reservoirs.
- It is used to understand the aquifer level.
- Assessing the effectiveness of water-engineering remedial measures.
- It is used to find depth.
- Mineral exploration of massive sulphide ore bodies.

QUANTITATIVE USES

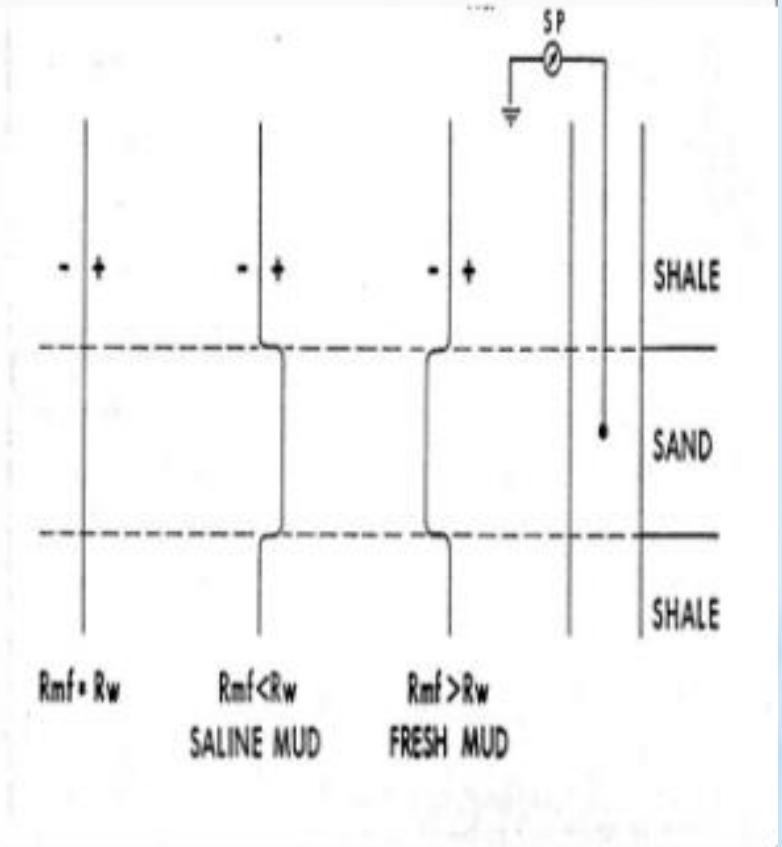
1. Determination of Formation Water Resistivity

The relationship between the SP and the resistivities of the mud filtrate and the formation water are determined

$$SP = -K \log (Rmf)e/(Rw)e$$



- When mud filtrate salinities are lower than connate water salinities (i.e., Rmf is > Rw), the SP deflects to the left (the SP potential is negative). This is called a normal SP.
- When the salinities are reversed (i.e., salty mud and fresh formation water, Rmf < Rw), the SP deflects to the right. This is called a reverse SP.
- Other things being equal, there is no SP at all when Rmf = Rw.



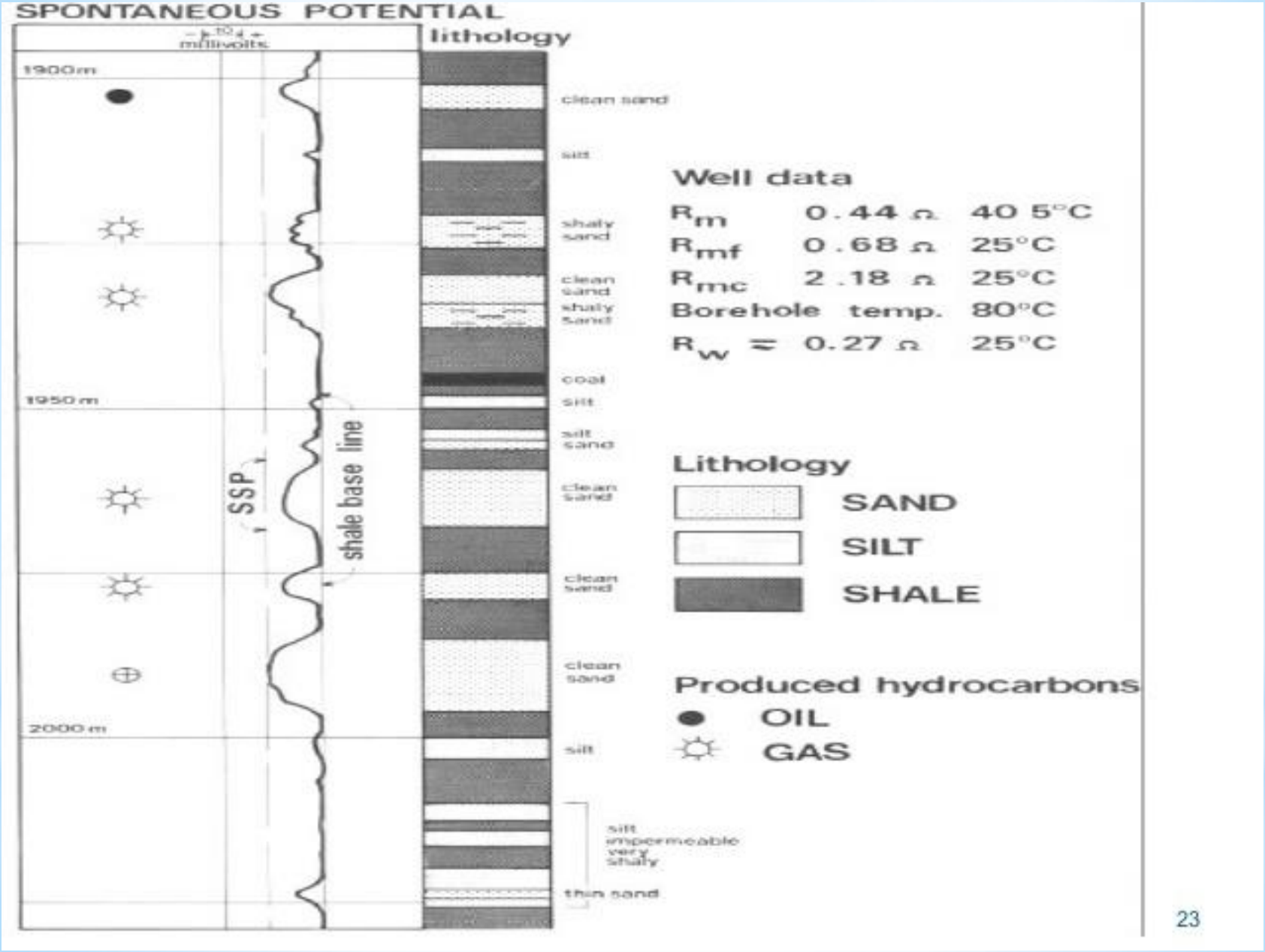
2. Shale Volume Calculation

- **Shale Base Line**

Th definition of s.p zero is made on thick shale intervals where s.p does not move to the left or right is called shale base line.

Static sp: (ssp)

The theoratical maximum deflection of s.p opposite permeable beds is called static s.por ssp. It is maximum possible s.p opposite a permeable water bearing formation with no shale.


SPONTANEOUS POTENTIAL
millivolts
lithology
1900 m
1950 m
2000 m
SSP
shale base line
clean sand
silt
shaly sand
clean sand
shaly sand
coal
silt
silt sand
clean sand
clean sand
clean sand
silt
silt impermeable very shaly
thin sand
Well data
R_m 0.44 Ω 40 5°C
R_{mf} 0.68 Ω 25°C
R_{mc} 2.18 Ω 25°C
Borehole temp. 80°C
R_w = 0.27 Ω 25°C
Lithology
SAND
SILT
SHALE
Produced hydrocarbons
OIL
GAS

2. Shale Volume Calculation:

$$V_{shale} = (SP_{clean} - SP_{log})/(SP_{clean} - SP_{shale})$$

V_{shale}: shale volume

SP_{clean}: maximum Sp deflection from clean wet zone

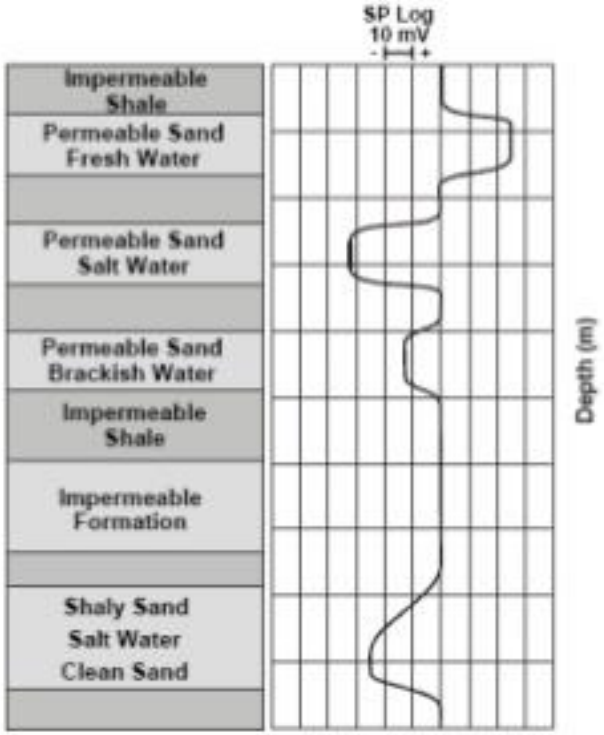
SP_{log}: Sp in the zone of interest (read from the log)

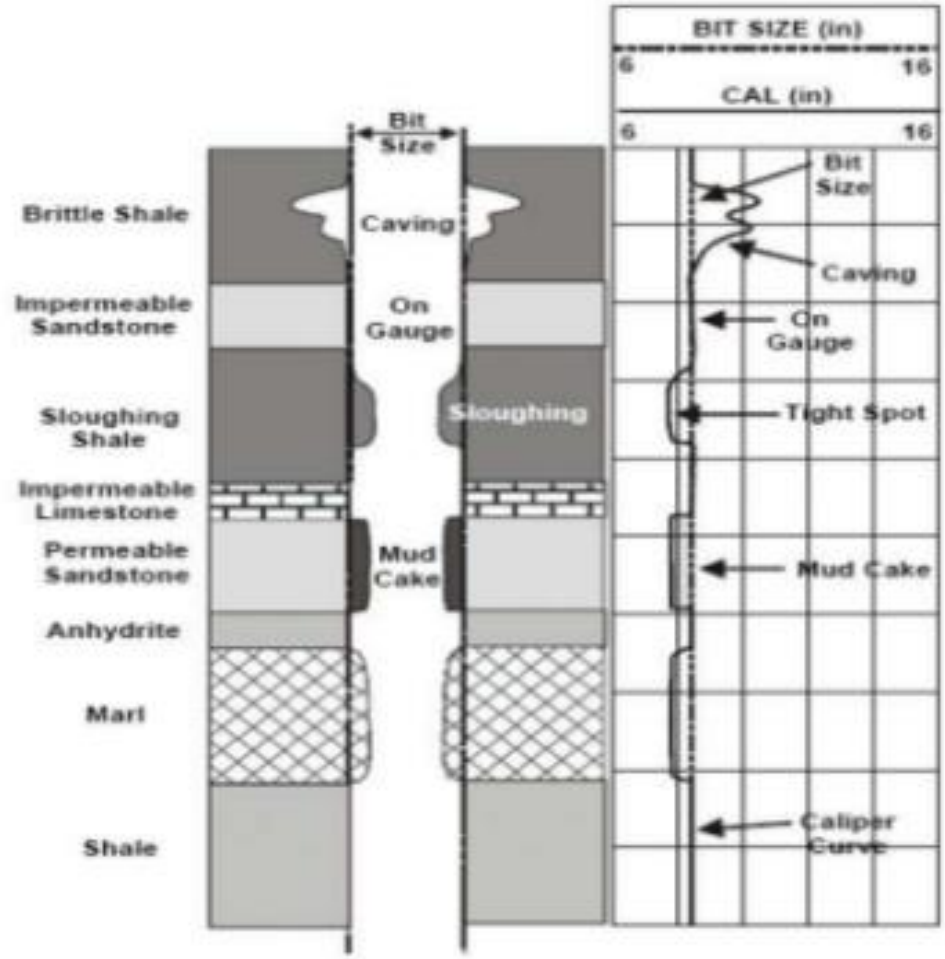
Sp_{shale}: SP value at the shale baseline (often considered to be zero)

QUALITATIVE USES

1. Detection of Permeability and Lithology

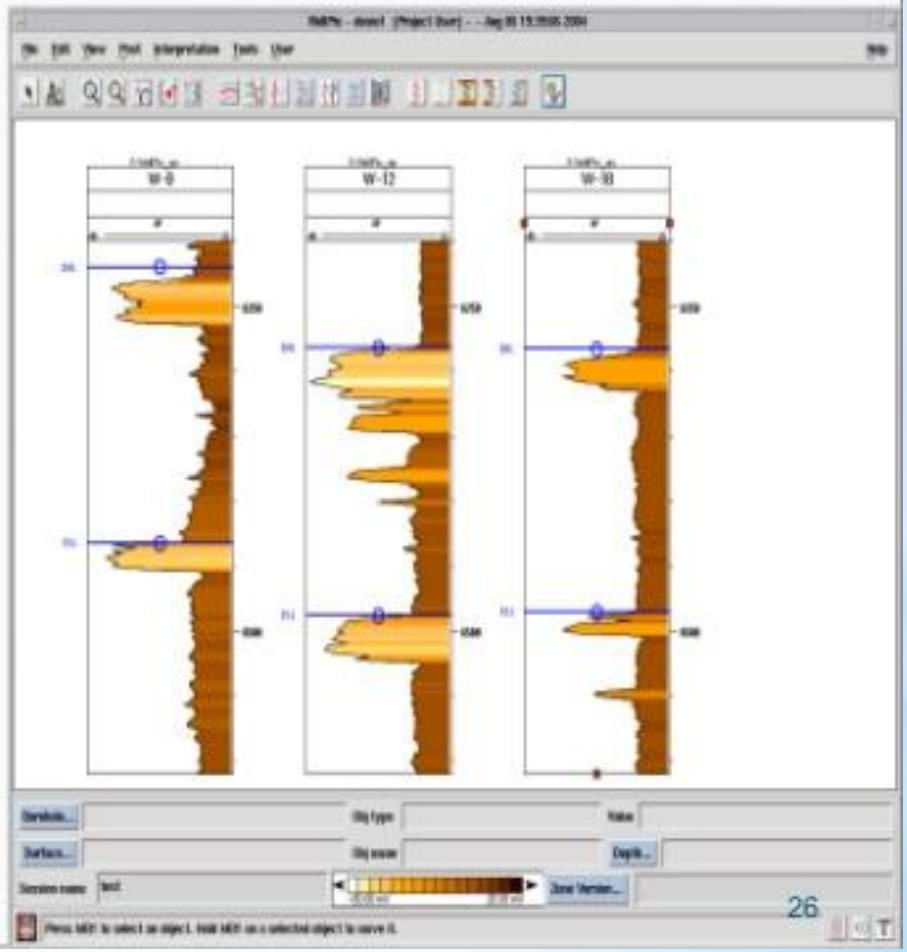
- If there is even a slight deflection on SP the bed opposite the deflection is permeable.



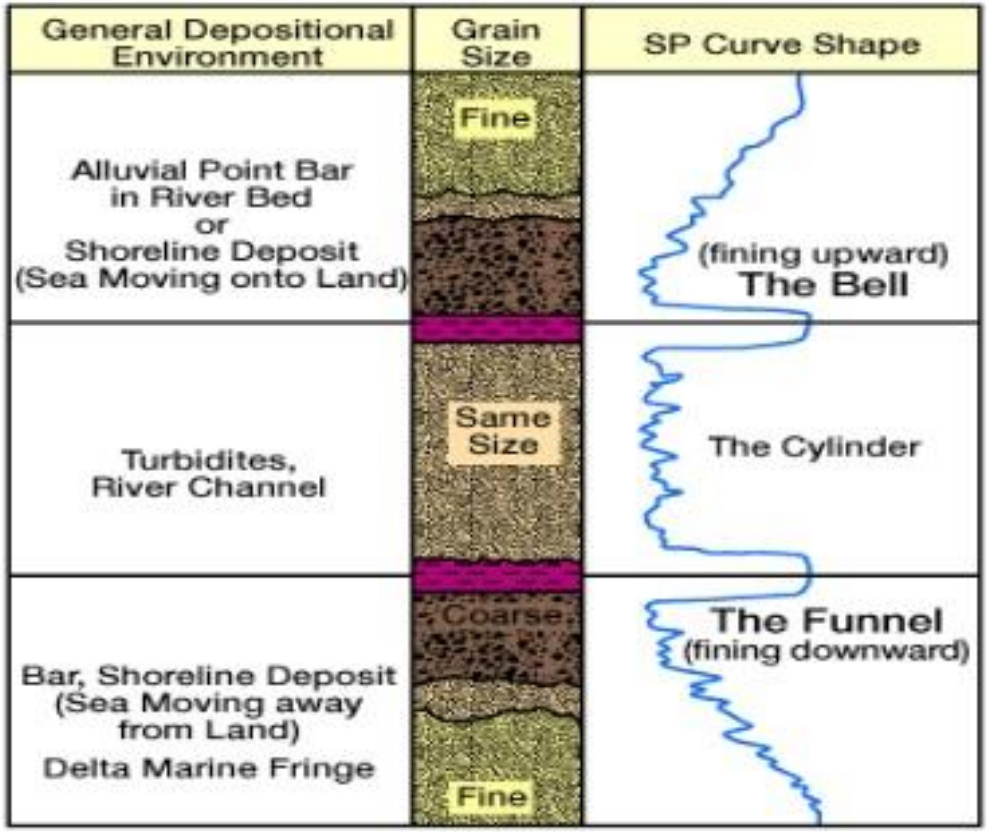

BIT SIZE (in)
6
16
CAL (in)
6
16
Bit Size
Caving
On Gauge
Sloughing
Mud Cake
Brittle Shale
Impermeable Sandstone
Sloughing Shale
Impermeable Limestone
Permeable Sandstone
Anhydrite
Marl
Shale
Bit Size
Caving
On Gauge
Tight Spot
Mud Cake
Caliper Curve

2. Correlation of formations

- Correlation by SP log has been replace by Gamma Ray log.
- Because Gamma Ray Log has more character and more repeatable.



3. Facies


General Depositional Environment
Grain Size
SP Curve Shape
Alluvial Point Bar in River Bed or Shoreline Deposit (Sea Moving onto Land)
Fine
(fining upward)
The Bell
Turbidites, River Channel
Same Size
The Cylinder
Bar, Shoreline Deposit (Sea Moving away from Land)
Delta Marine Fringe
Coarse
Fine
The Funnel
(fining downward)