

# Well Logging

## ELECTRICAL LOGS SP Log

**Mining Engineering Department/ 3<sup>rd</sup> Year**

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# ELECTRICAL LOGS

Recording of one or more electrical properties of rocks for use in estimating their fundamental properties (Porosity, Saturation, etc).

There are two main types of electrical logs:

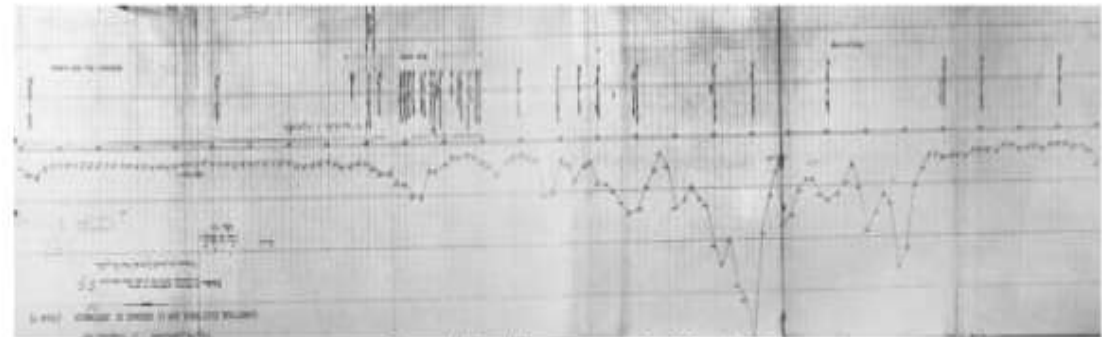
- 1 • **Self Potential**
- 2 • **Resistivity**



Well in Pechelbronn - France



Surface Recording Instrument

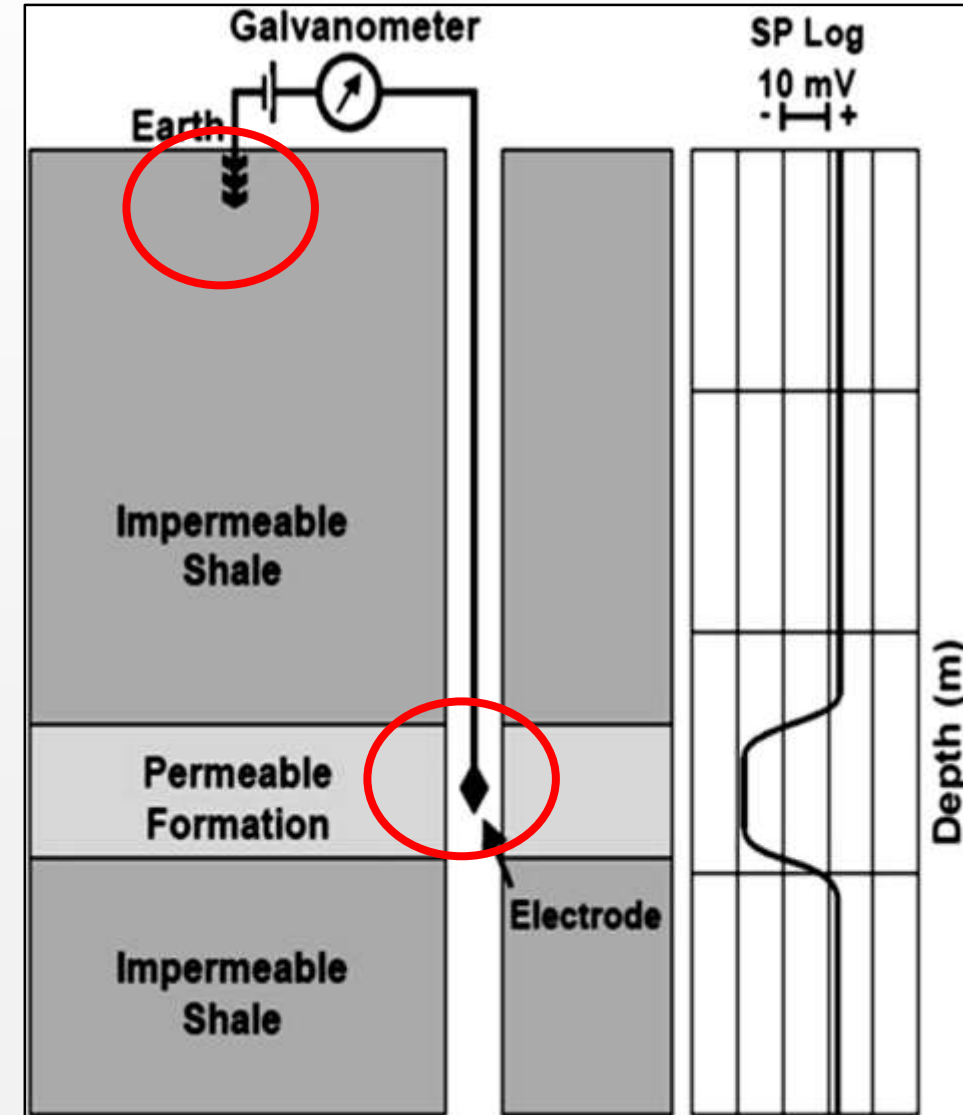


The "First" Log recorded in 1927

# Self-Potential / Spontaneous Potential (SP) Log

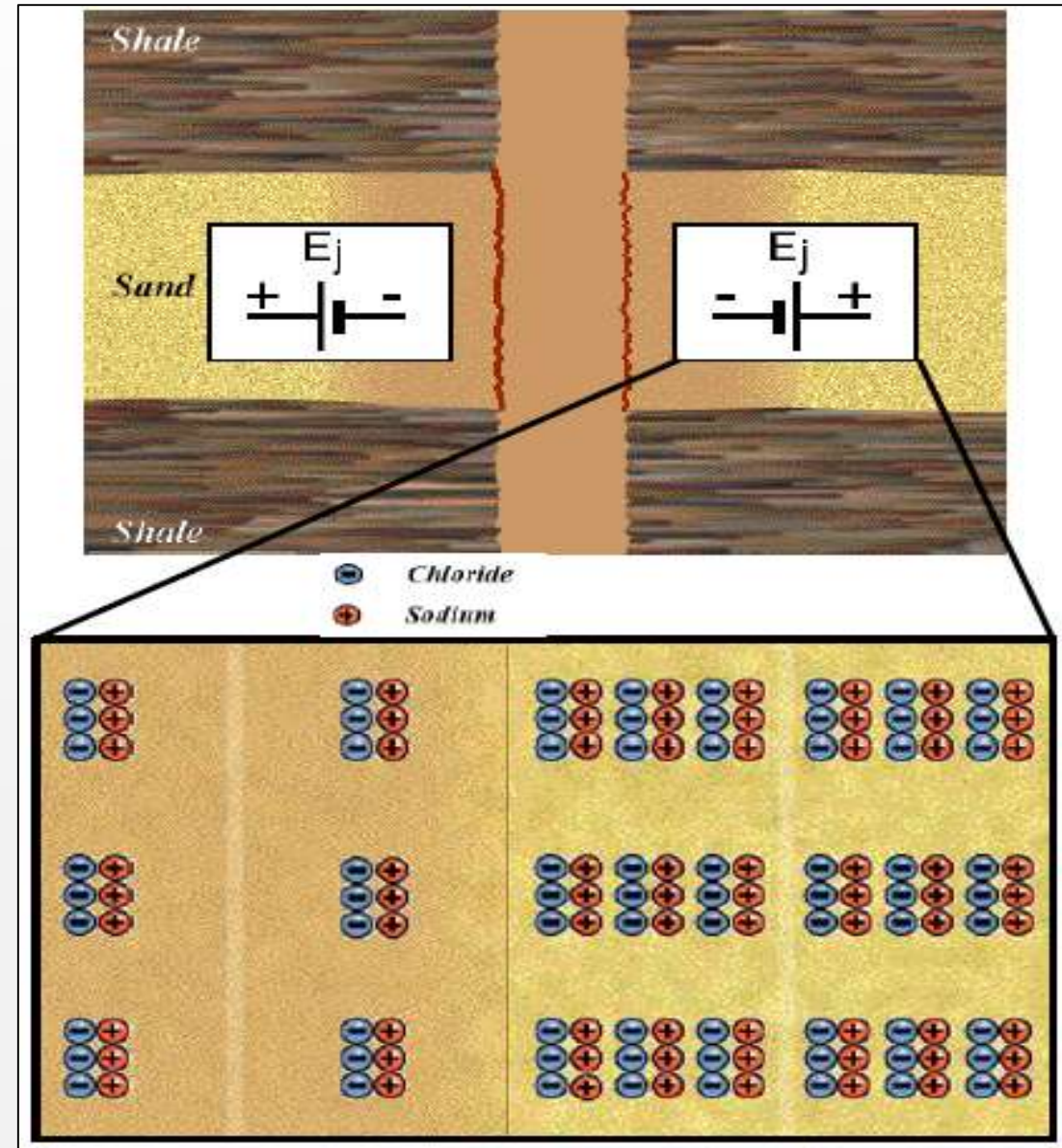
**The SP log:** is a record of direct current voltage (or potential) that develops naturally (or spontaneously) between a moveable electrode in the well bore and a fixed electrode located at the surface.

It is measured in millivolts (mV).



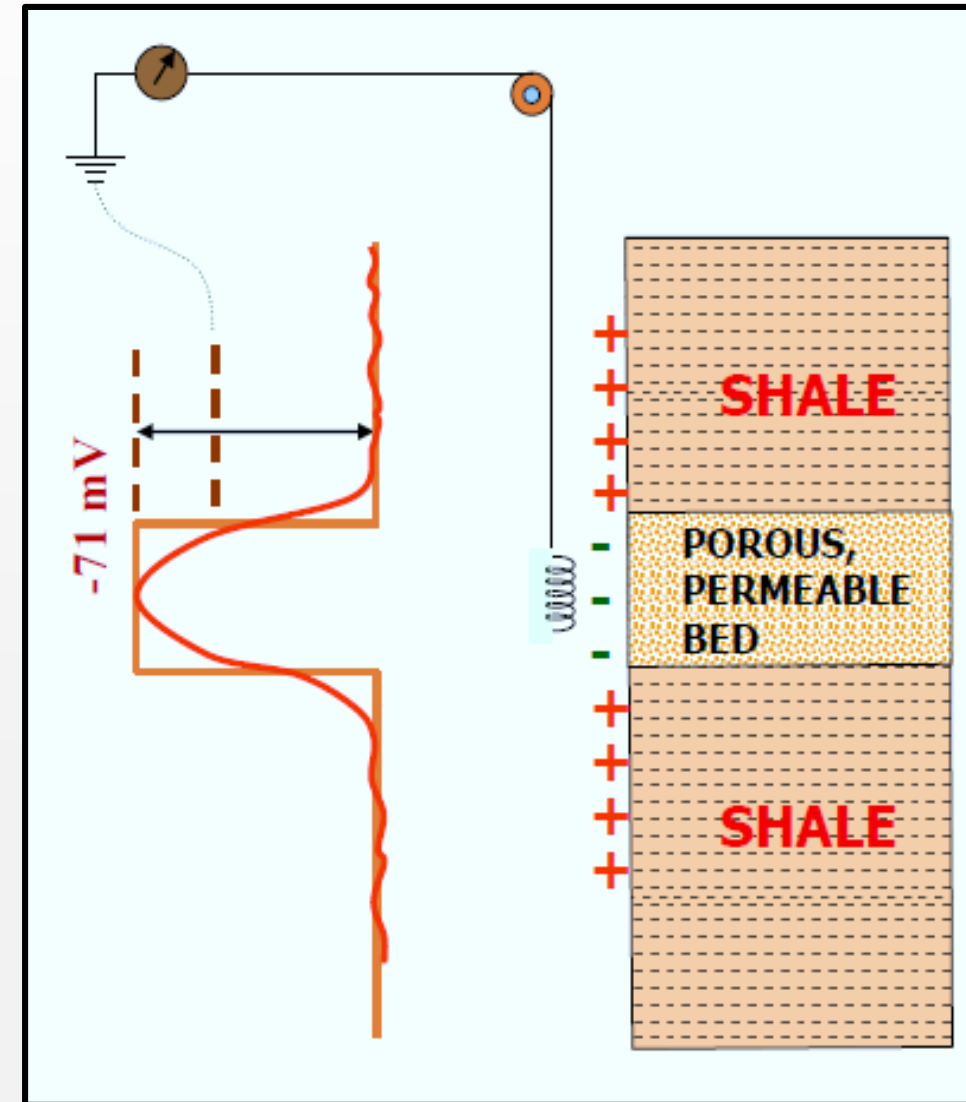
# How Electrical Voltages are Produced?

by the differences in the salinities (resistivities) of the formation connate water ( $R_w$ ) and the drilling mud filtrate ( $R_{mf}$ ), and by the presence of ion selective shale beds.



# What are The Requirements of SP Current?

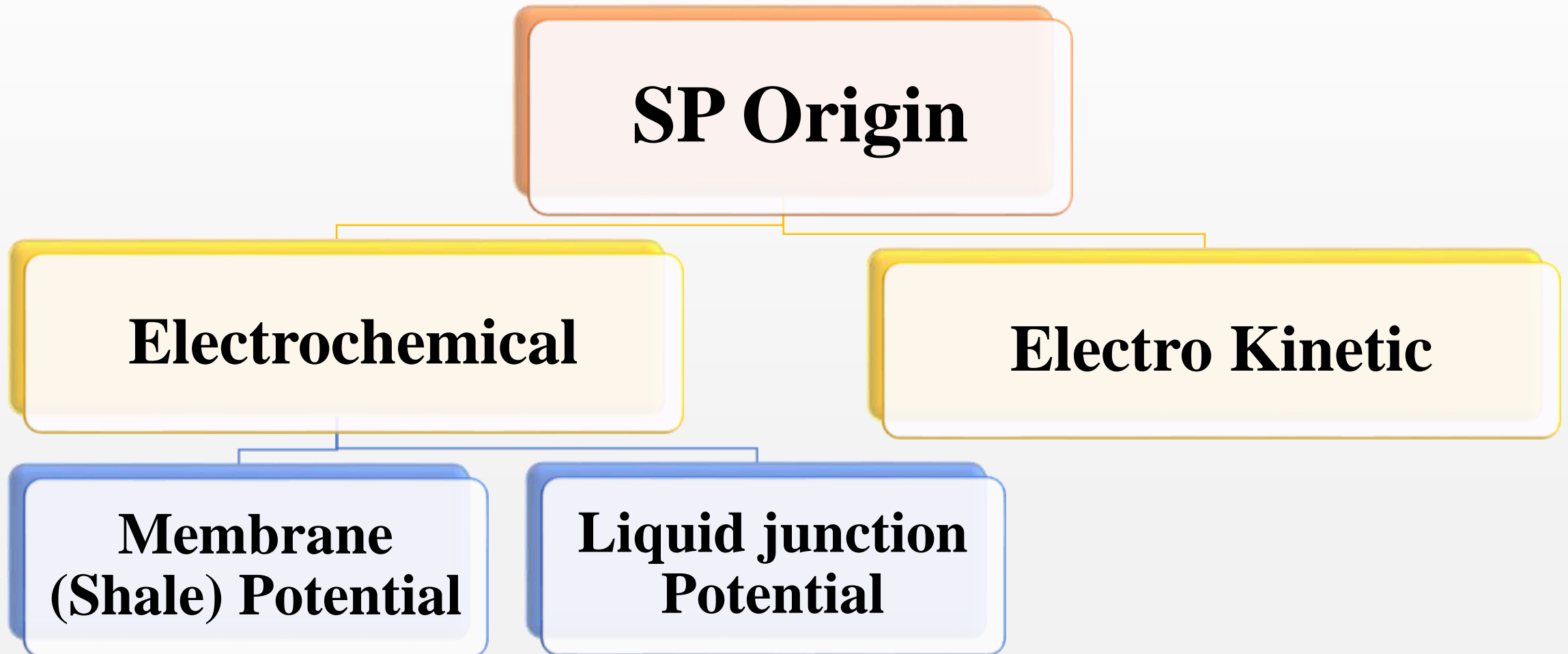
1. A conductive borehole fluid (i.e. a water-based mud), therefore the SP cannot be recorded in air or oil-base mud.
2. A porous and permeable bed inserted between low porosity and impermeable formations.
3. A difference in salinity to the borehole (the mud filtrate and the formation fluid).



# Uses of SP Logs

- Detect permeable beds & Lithology.
- Identify boundaries of permeable beds.
- Determine formation-water resistivity ( $R_w$ ).
- Determine the volume of shale ( $V_{sh}$ ) in permeable beds.
- Detection of hydrocarbons.
- Correlation.

# The Source (Origin) of SP



# 1-Membrane (Shale) Potential:

- Membrane potential ( $E_m$ ) OR ( $E_s$ ) is created near the boundaries of shale beds and permeable beds.

## Movement of Positive Charge (++++)

1- layered clay structure and charges on the layer

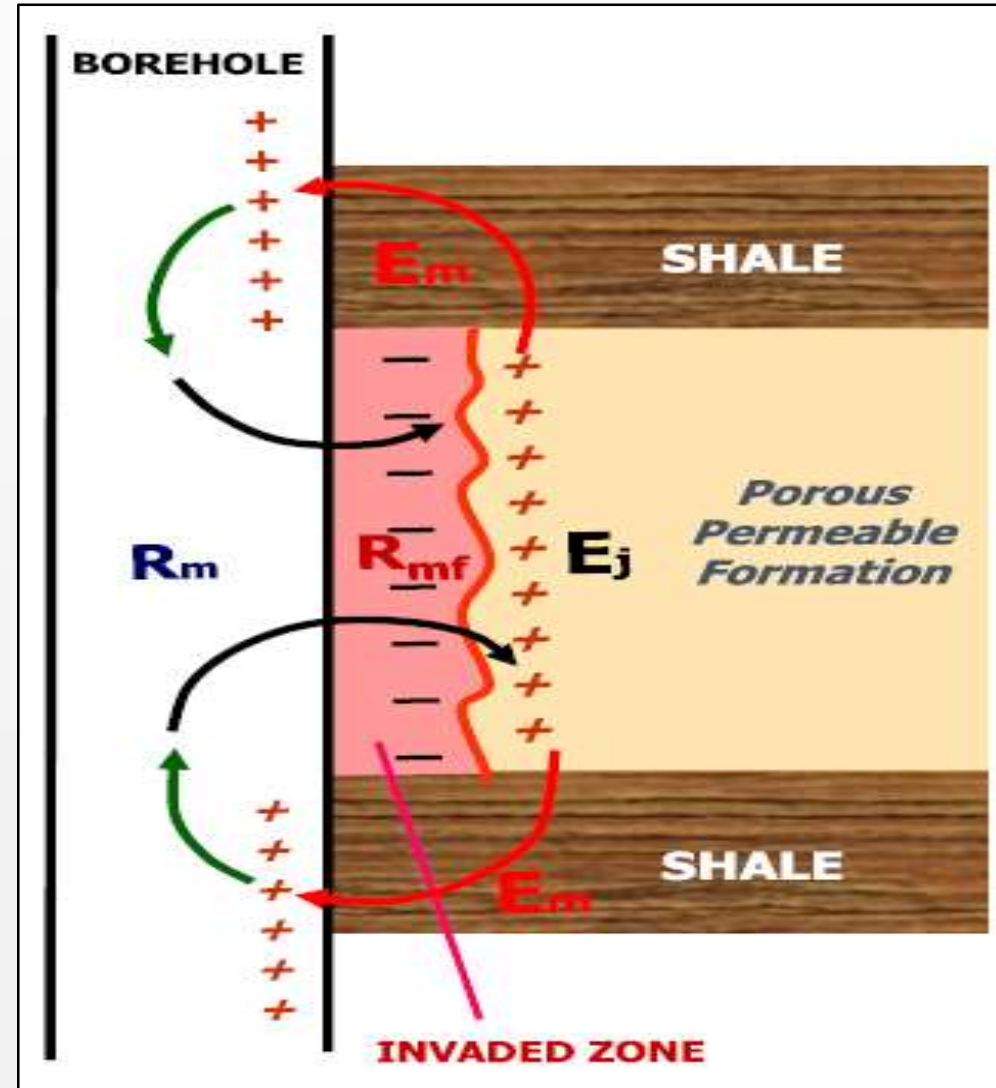
(Permeable to  $\text{Na}^+$ )

2- Sodium ions ( $\text{Na}^+$ ) flow from

Formation water  $\longrightarrow$  to shale  $\longrightarrow$

to borehole mud

So, a current will be created moving from the mud or mud filtrate to the uninvaded zone through the shale and back to the mud or mud filtrate

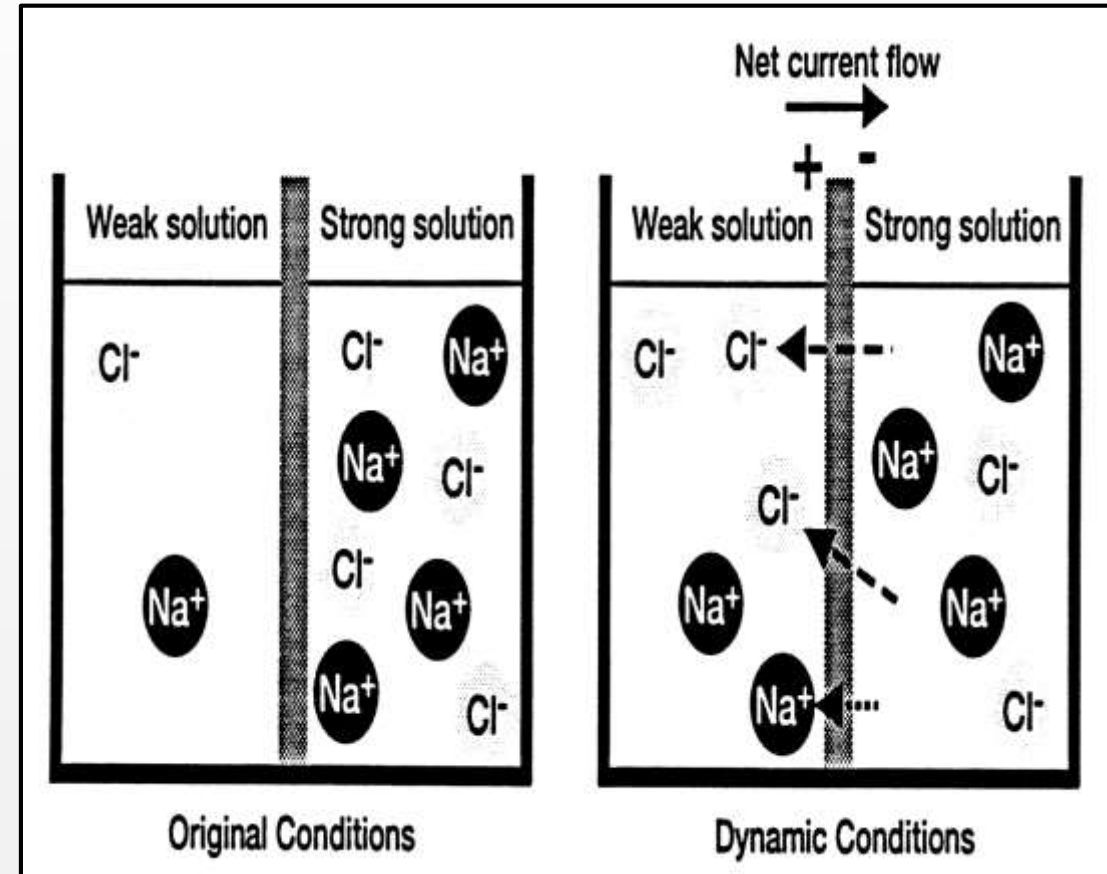


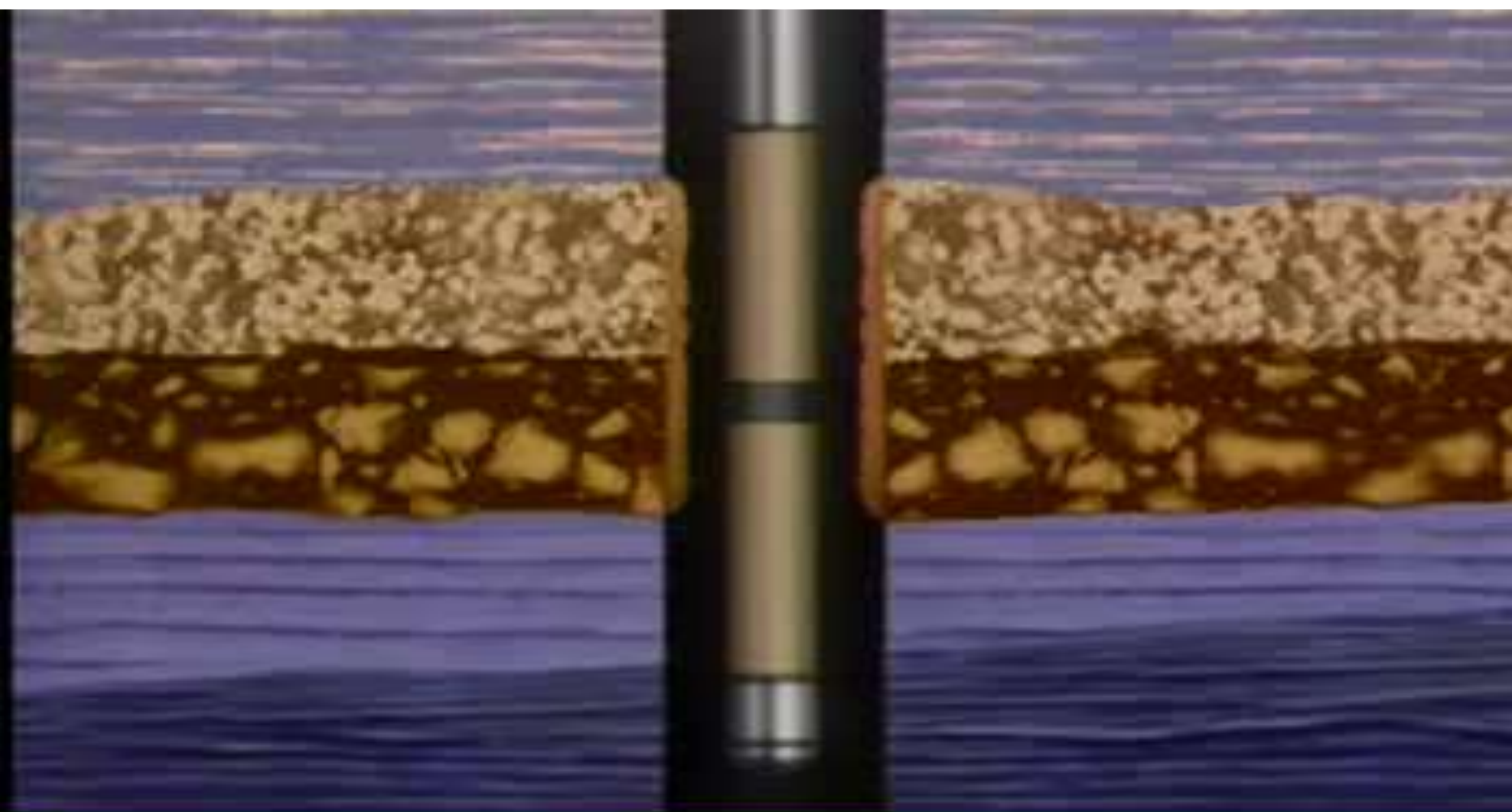


## 2-Liquid junction Potential (Diffusion Potential):

### Negative potential (----)

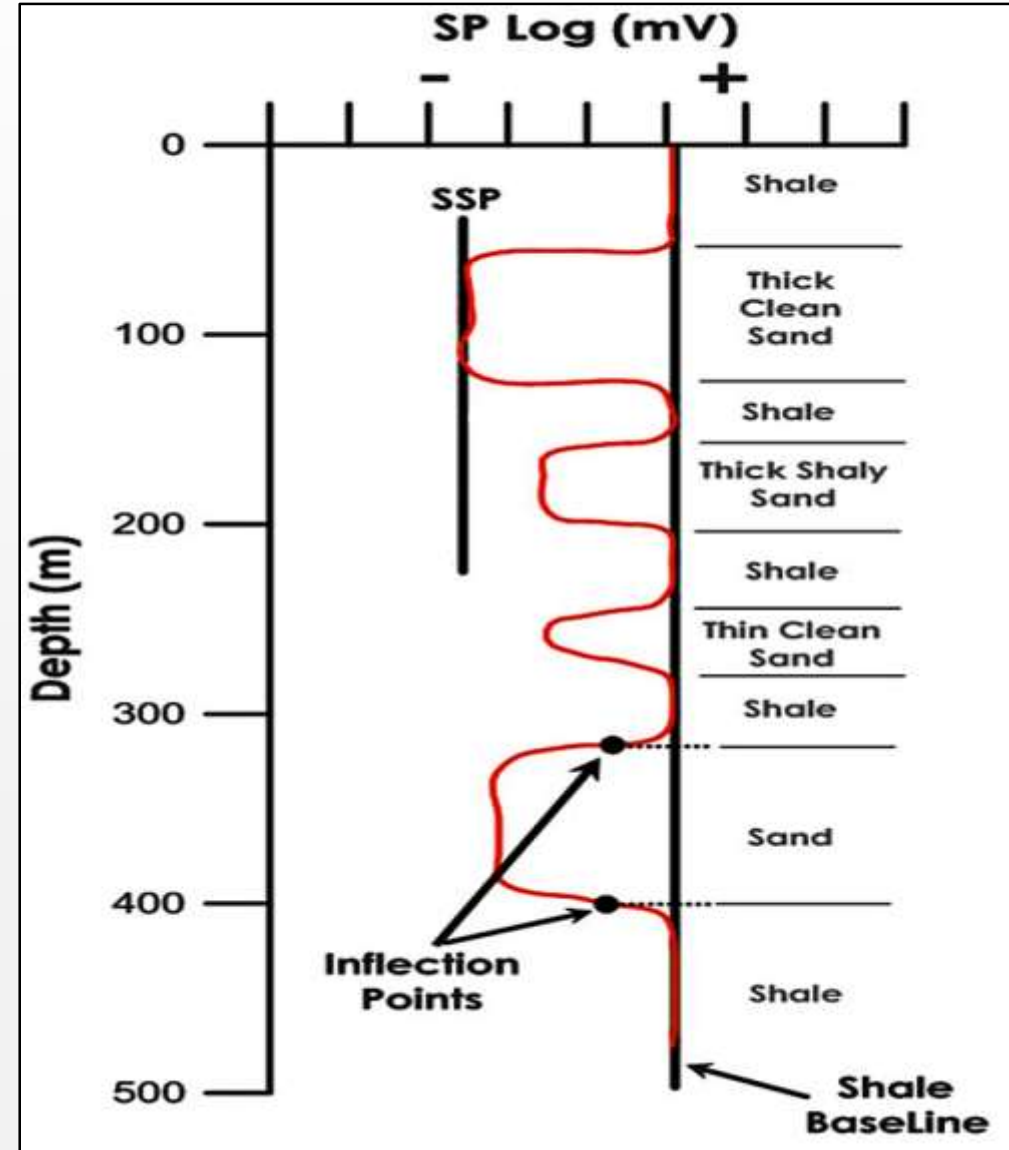
- Two different concentration of sodium chloride solutions *semi-permeable barrier* is created. This barrier keeps the solutions from mixing
- The Cl<sup>-</sup> ions move from [formation water](#) to [mud filtrate](#)
- the Cl<sup>-</sup> ions (*lighter*) have *greater mobility than the Na<sup>+</sup> ions* and thus *move more rapidly*.
- This rapid movement generates a [negative potential \(----\)](#) across the liquid junction.



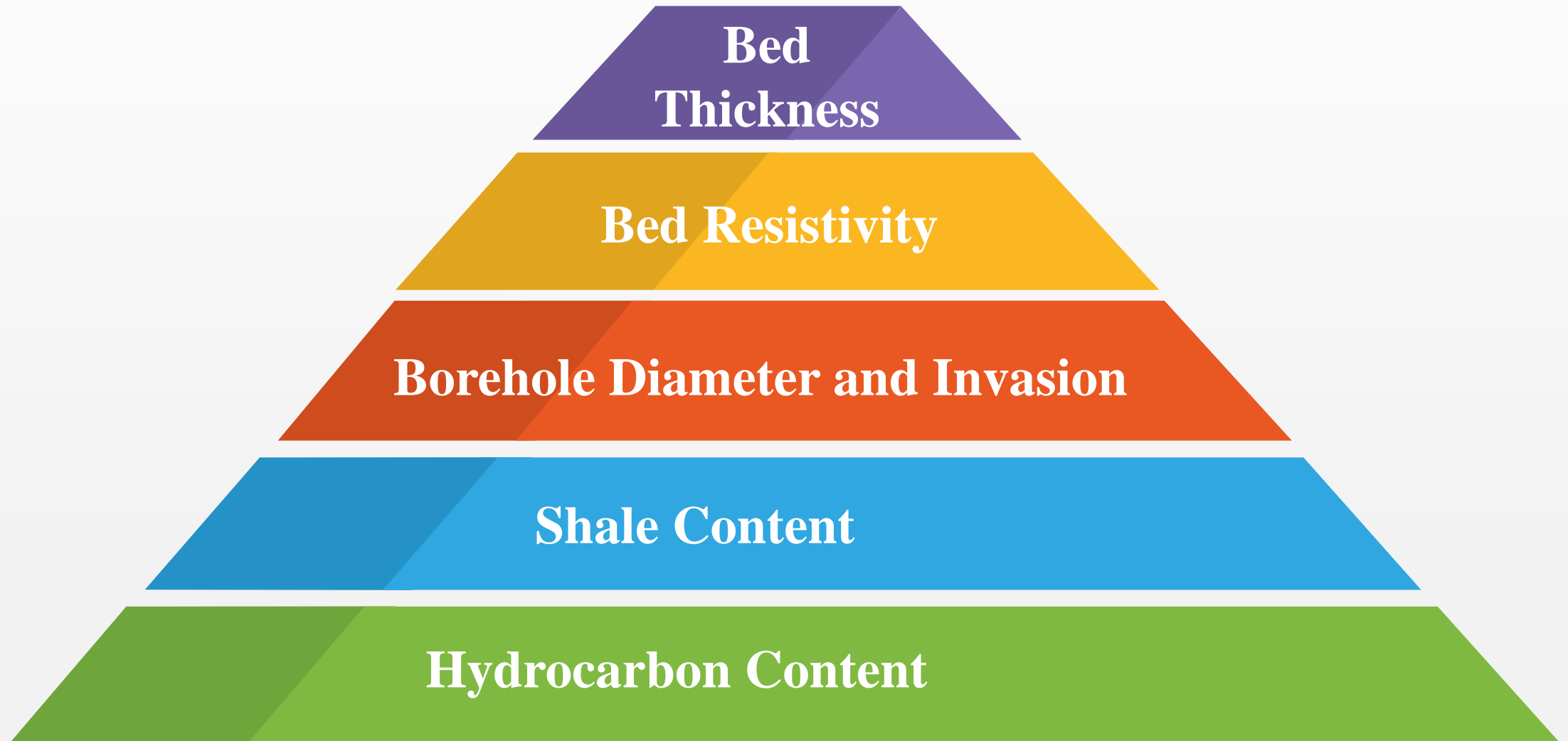


# Static Spontaneous Potential (SSP)

The concept of (**SSP**) is important because SSP represents the maximum SP that a thick, shale-free, porous, and permeable formation can have for a given ratio between  $R_{mf}$  and  $R_w$



# The Main Factors That Influence on SP Values



# SP Deflection

1- No deflection ( $R_{mf} = R_w$ )

2- Negative deflection ( $R_{mf} > R_w$ )

3- Negative normal deflection ( $R_{mf} \gg R_w$ )

4- Positive deflection ( $R_{mf} < R_w$ )

