



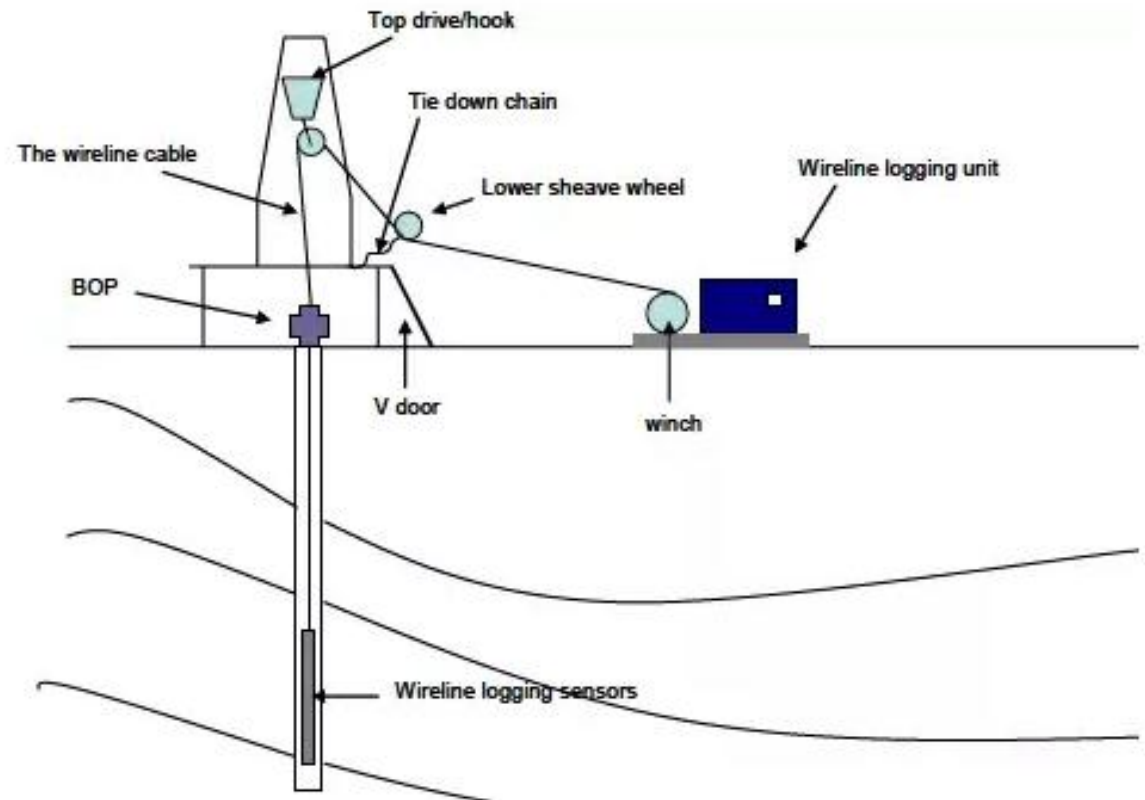
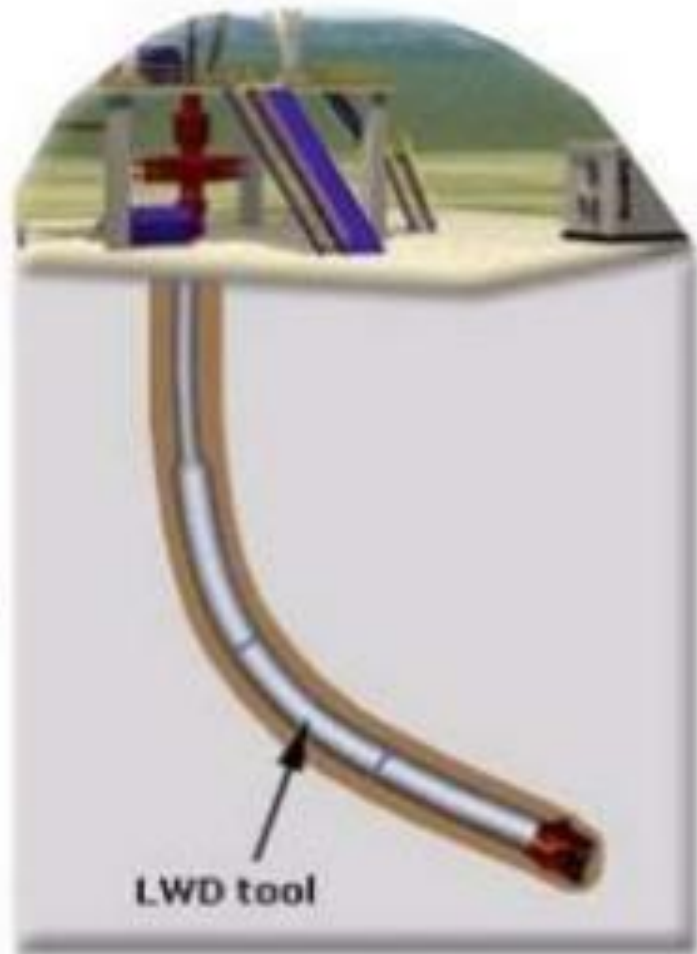
WL and LWD
Invasion profile
Spontaneous Potential



Wireline vs LWD



LWD



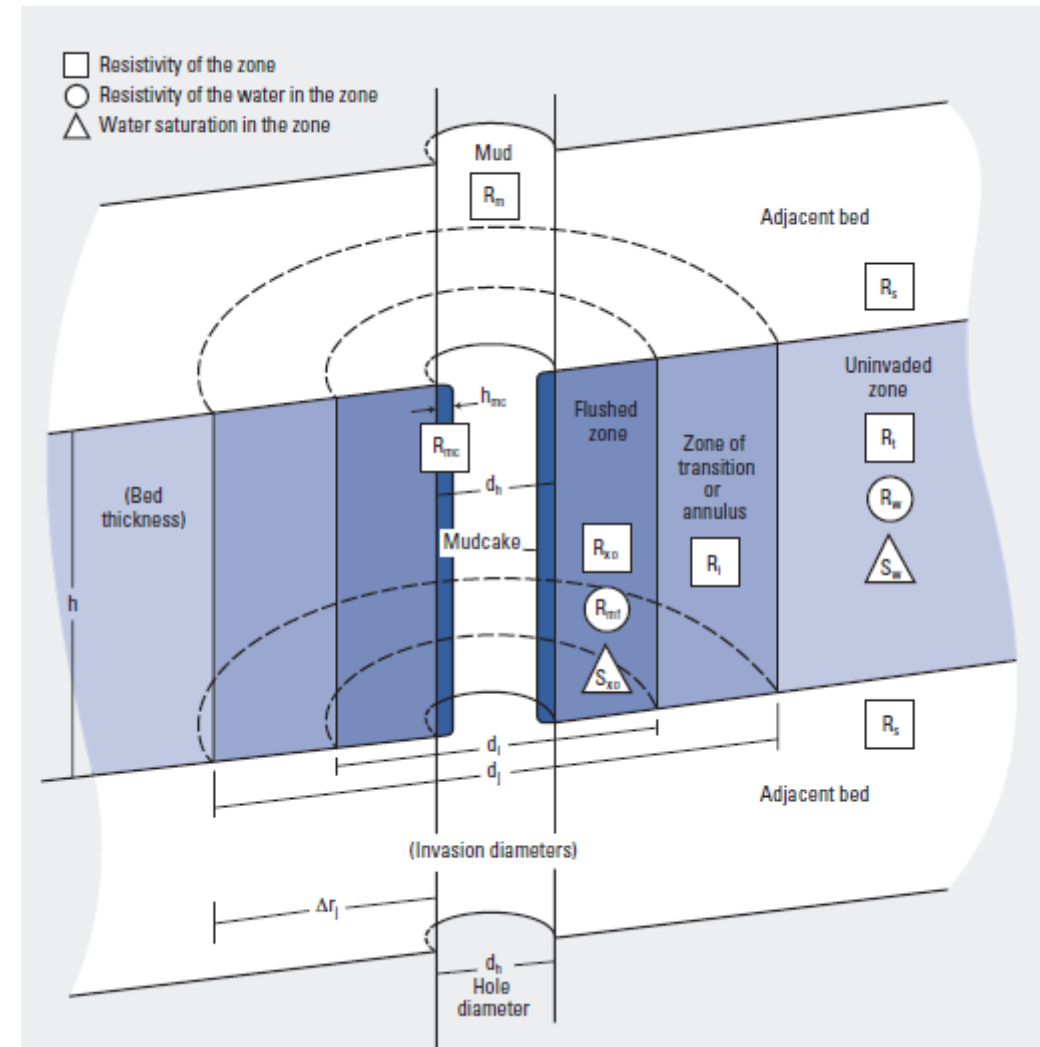
Wireline vs LWD



- Wireline
- Small, light
- Since the 30s
- High data speed
- Easy communication
- Powered through cable
- Long time after bit
- Not capable in high deviation
- LWD
- Heavy big and tough
- Since the 70s
- Slow telemetry
- Limited control
- Powered with battery
- Real time recording while drilling
- Capable in tough environment

Invasion profile

- Mud is under pressure that is higher than formation pressure.
- In permeable zones mud will infiltrate in the formation leaving mud particle at the face of the formation which will form mud cake
- When mud filtrate invade the formation this will stop the mud filtrate from traveling farther in the formation
- Then 3 major zones will be created, flushed zone, transition zone, and true formation zone.
- The resistivity of these zones will change because of different fluid in each zone.



Introduction



- One of the first logging measurement ever made.
- Sp curve record the naturally occurring electrical potential produced by the interaction of formation connate water, conductive drilling fluid and shale.
- Sp log is not being used now, because it has the same GR applications
- SP log also limited by the type of Mud. It will not work in oil based mud

Application of Spontaneous potential

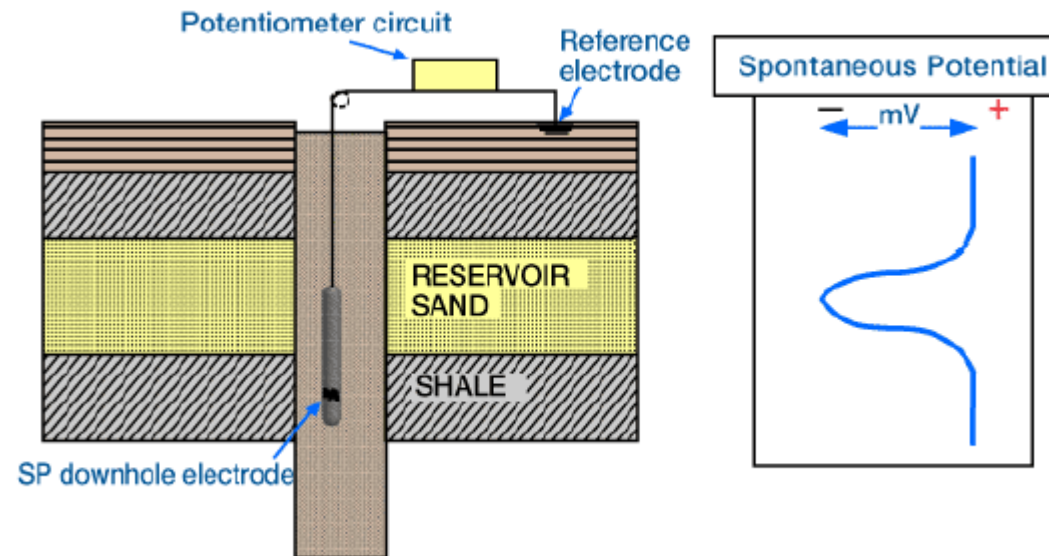


- Detection of permeable beds
- Location of reservoir boundaries.
- Determination of R_w
- Determination of shale beds.
- Correlation from well to well
- Indication on the environment of deposition.

Acquisition



- SP is recorded by sending one measuring electrode downhole (fish) and connected to measurement electrode at the surface.
- Voltage difference between 2 electrodes measured.



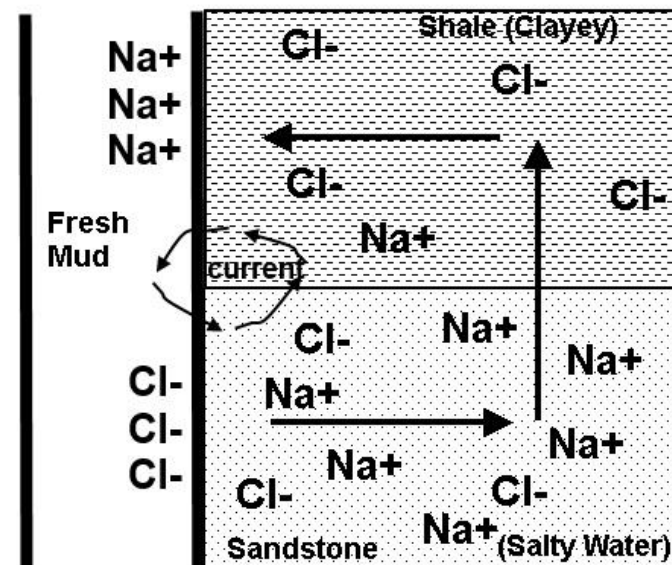
Theory of measurement



- There are 2 major component that cause the electrical current:
 - - Electrochemical Component
 - liquid junction potential
 - Membrane potential
 - - Electrokinetic component

Liquid Junction potential

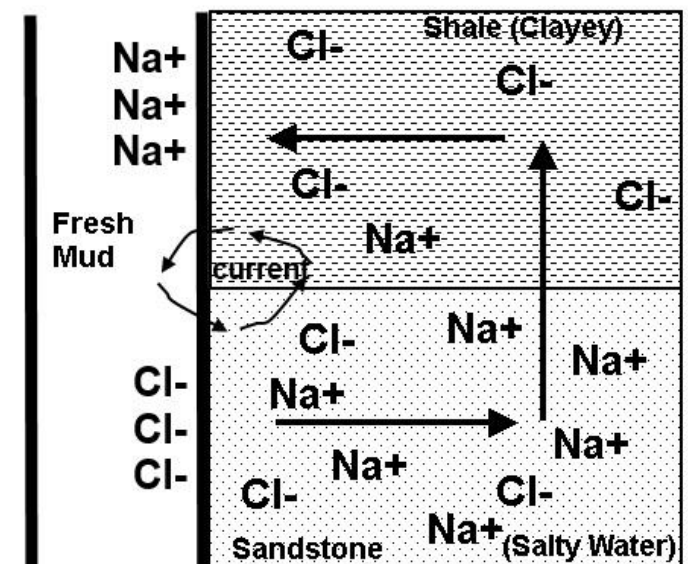
- When 2 solution of different salinity concentration are on contact there will be transfer of the ions from higher salinity to lower salinity
- The negative ions have more mobility than positive ions. In case of mud with lower salinity the negative ions will move from formation toward mud.
- This will make SP deflect toward negative reading
- In case of invasion zone happened the liquid junction potential will happened at the enterface between formation water and the mud filterate.





Membrane potential.

- Shale can be permeable for one tupe of ion while acting as a barrier for another type.
- Shale can prevent the movement of the negative ions
- This will make positive potential generated toward the low concentration of salinity .
- This will make SP curve be toward positive



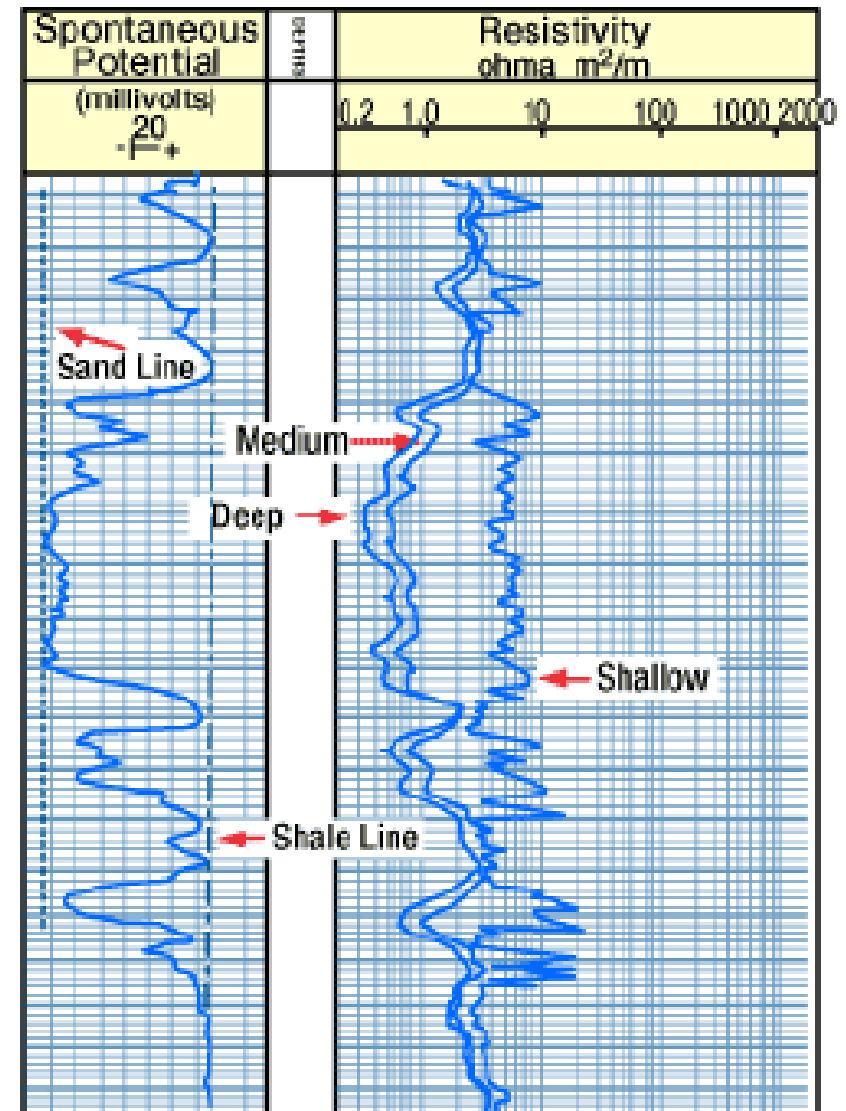
Electrokinetic potential



- Mudcake will act as membrane potential as well.
- This will retard the movement of negative potential and will make electrical potential difference.
- SP curve should be corrected for this effect.

Reading summary

- If the $R_{mf} > R_w$
- SP will deflect toward negative in sand zones
- SP will deflect toward positive in shale line.
- The deflection magnitude depend on the salinity difference between 2 fluids.





Shale volume calculation

- It is also possible to calculate shale volume from SP curve.

$$(V_{sh})_{SP} = \frac{SP_{log} - SP_{sand}}{SP_{shale} - SP_{sand}}$$