



CASED HOLE & PRODUCTION LOG EVALUATION

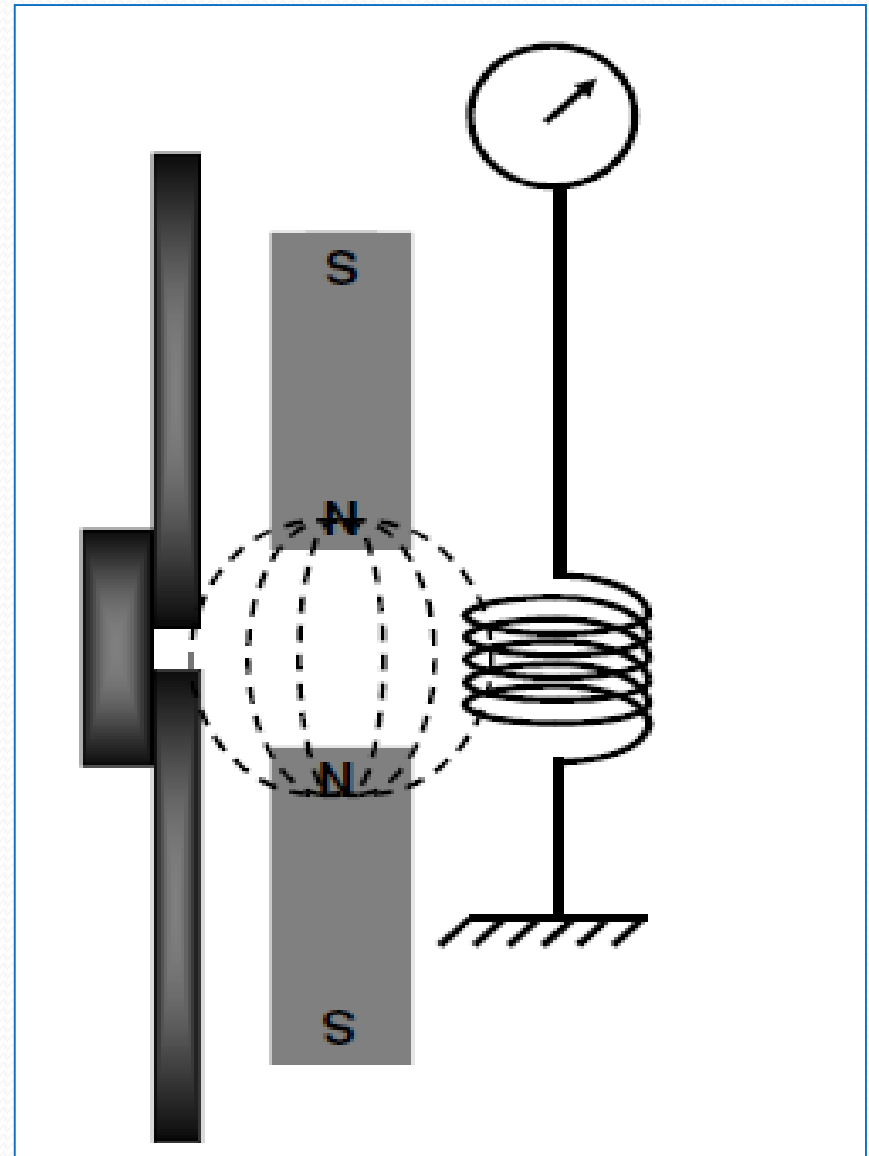
Technologies applied in cased hole

- ✓ Gamma ray (depth correlation and lithology identification).
- ✓ Acoustic logging (sonic logs and cement bond integrity).
- ✓ Neutron logging (lithology and fluid type determination).
- ✓ Pulsed neutron capture and spectral logging (fluid saturations).
- ✓ Production logging (productivity and flow profile).
- ✓ **Other cased services that are completion oriented:**
 - Perforating, plug and packer setting.
 - Tracers (water injection monitoring).
 - Gravel pack fill (Sand control).
 - Corrosion monitoring.

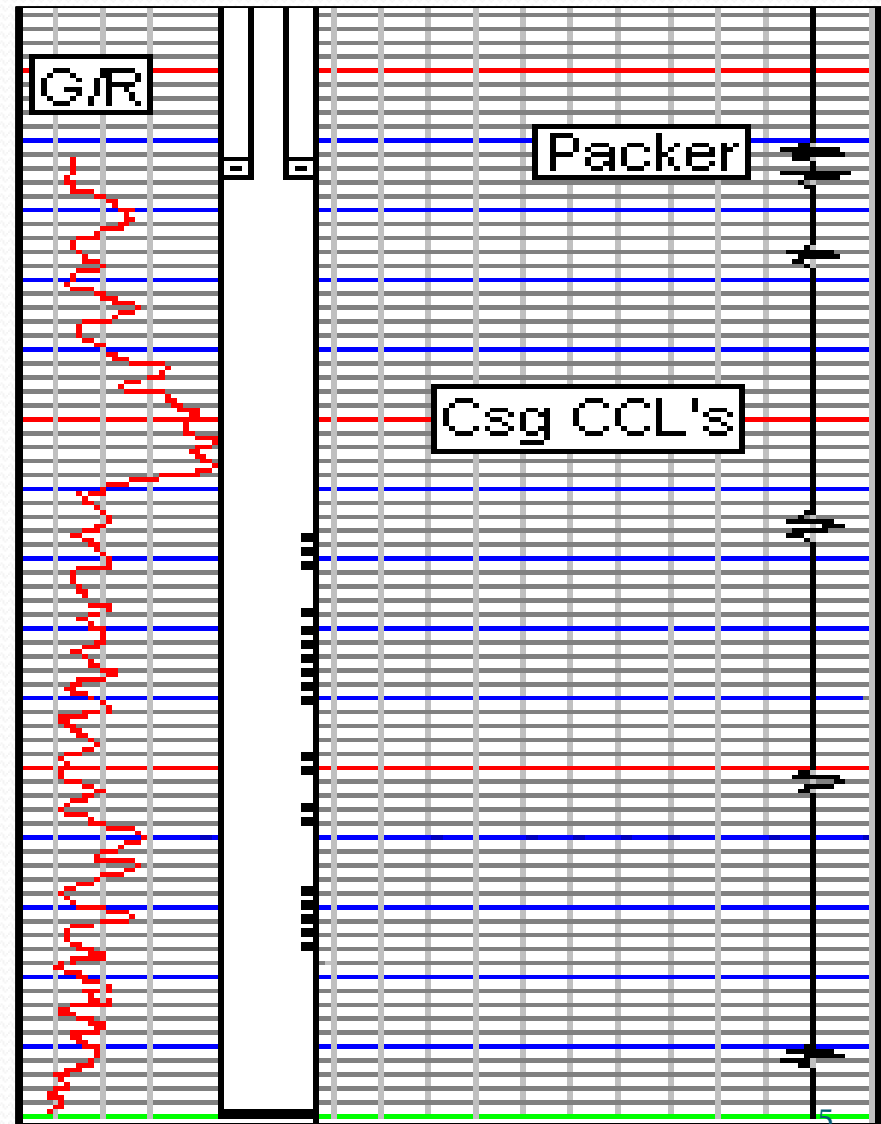
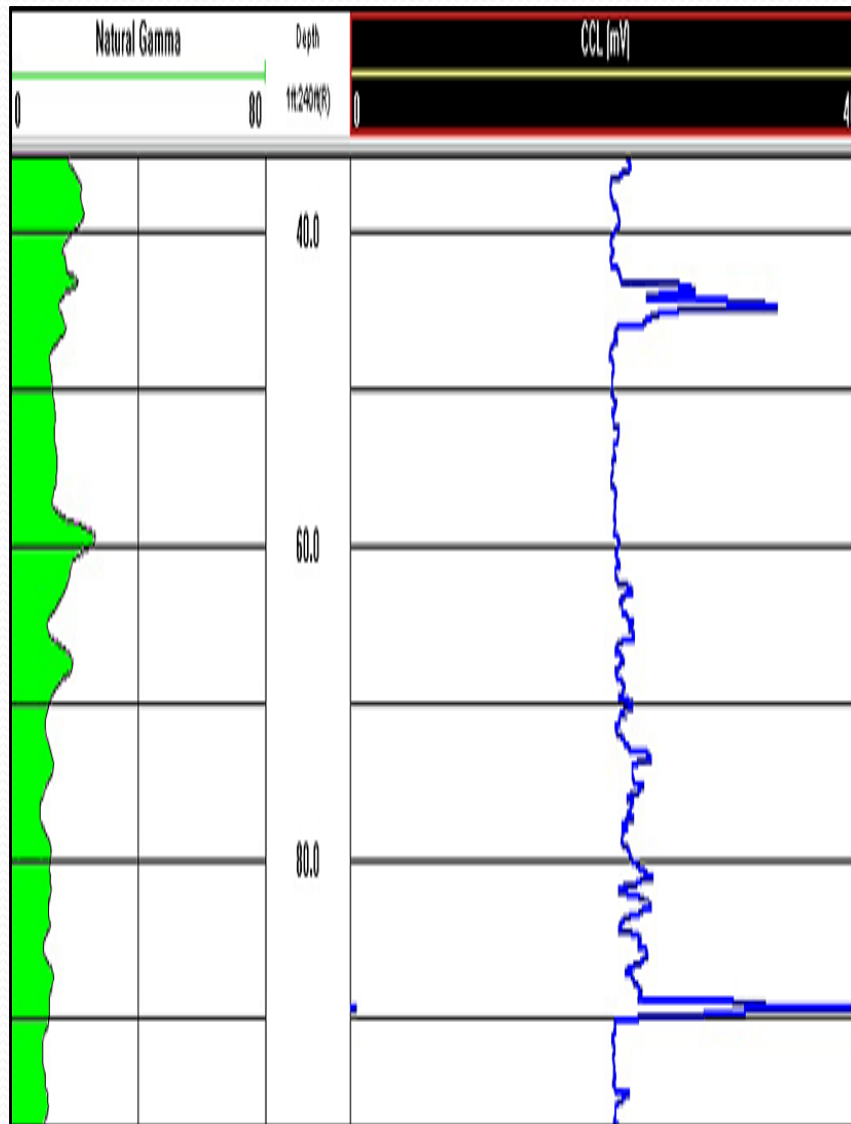


Gamma Ray & Casing Collar Locator (CCL)

- ✓ The magnetic lines of flux are distorted when the tool passes a location at which the metallic casing is enlarged by a collar.
- ✓ This distortion gives rise to a classical *change in the magnetic field* around the conducting coil, within which current is induced. The signal is amplified and recorded at the surface in the form of *a voltage spike* known as a collar "kick".



Correlation Gamma Ray And Collar Logs





Cement Evaluation

CEMENT PROBLEMS



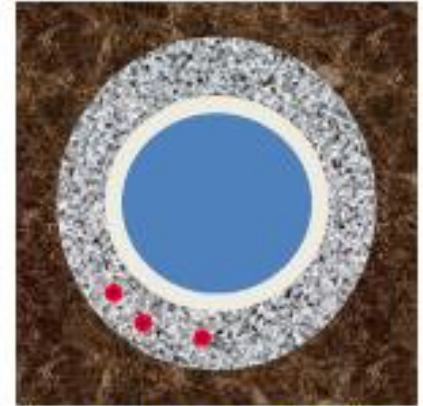
Micro-annulus
cement/formation



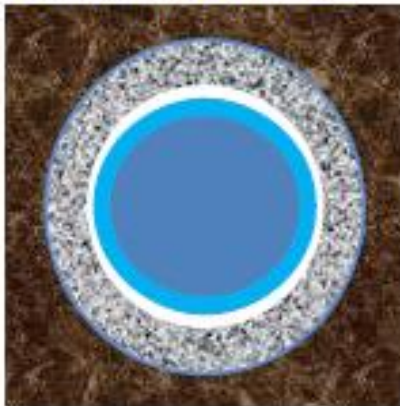
Excentralization



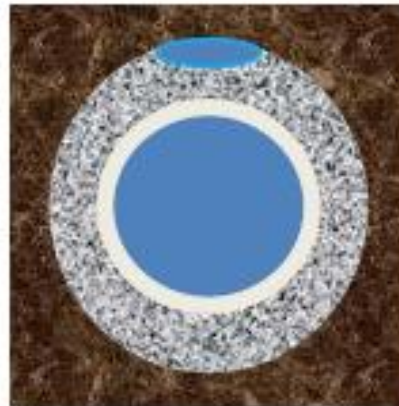
Weak cement



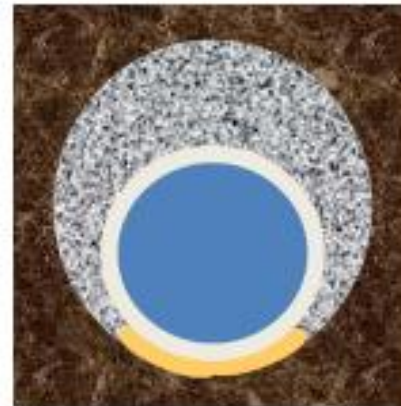
Gas channelling



Micro-annulus
casing/cement



Water channel

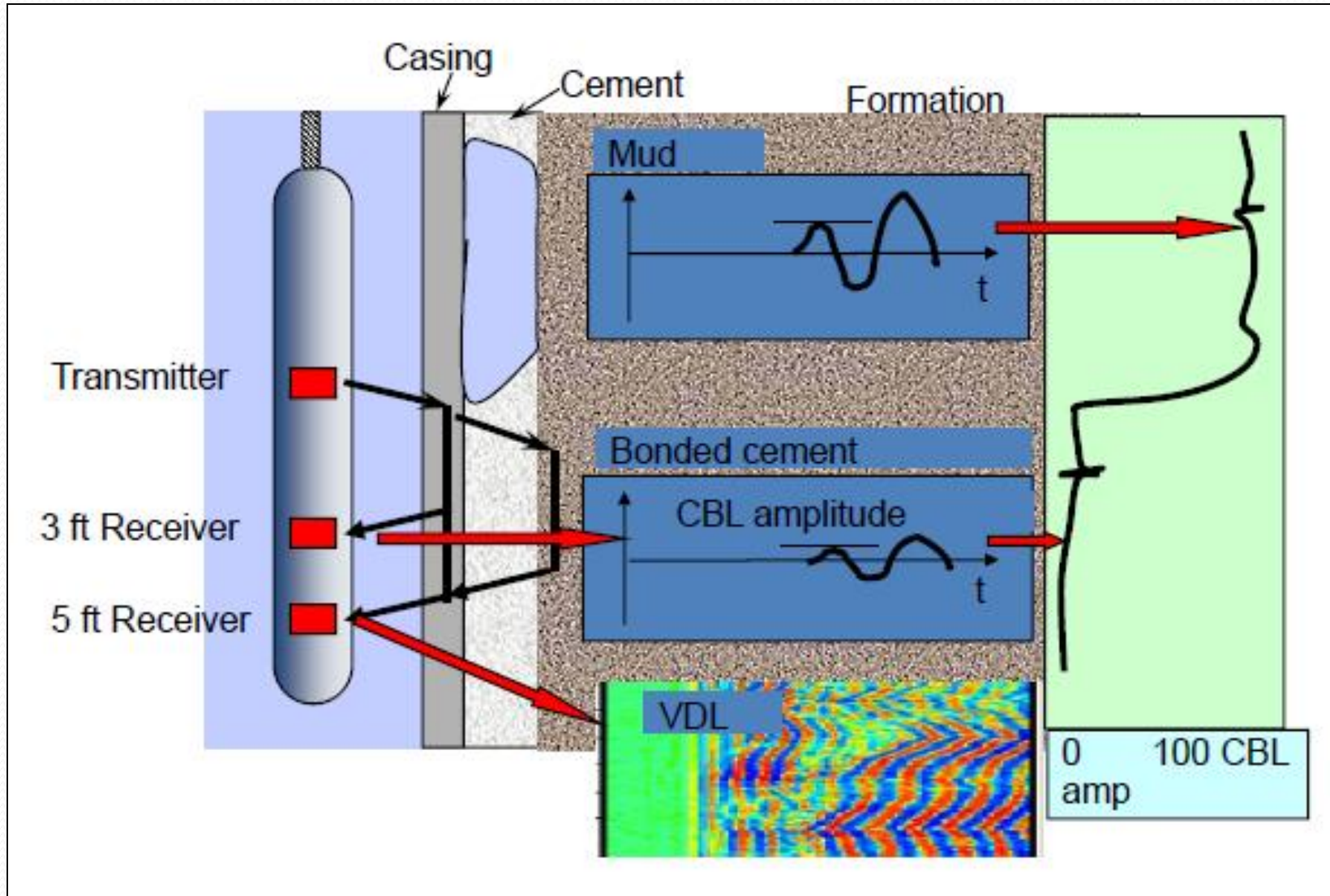


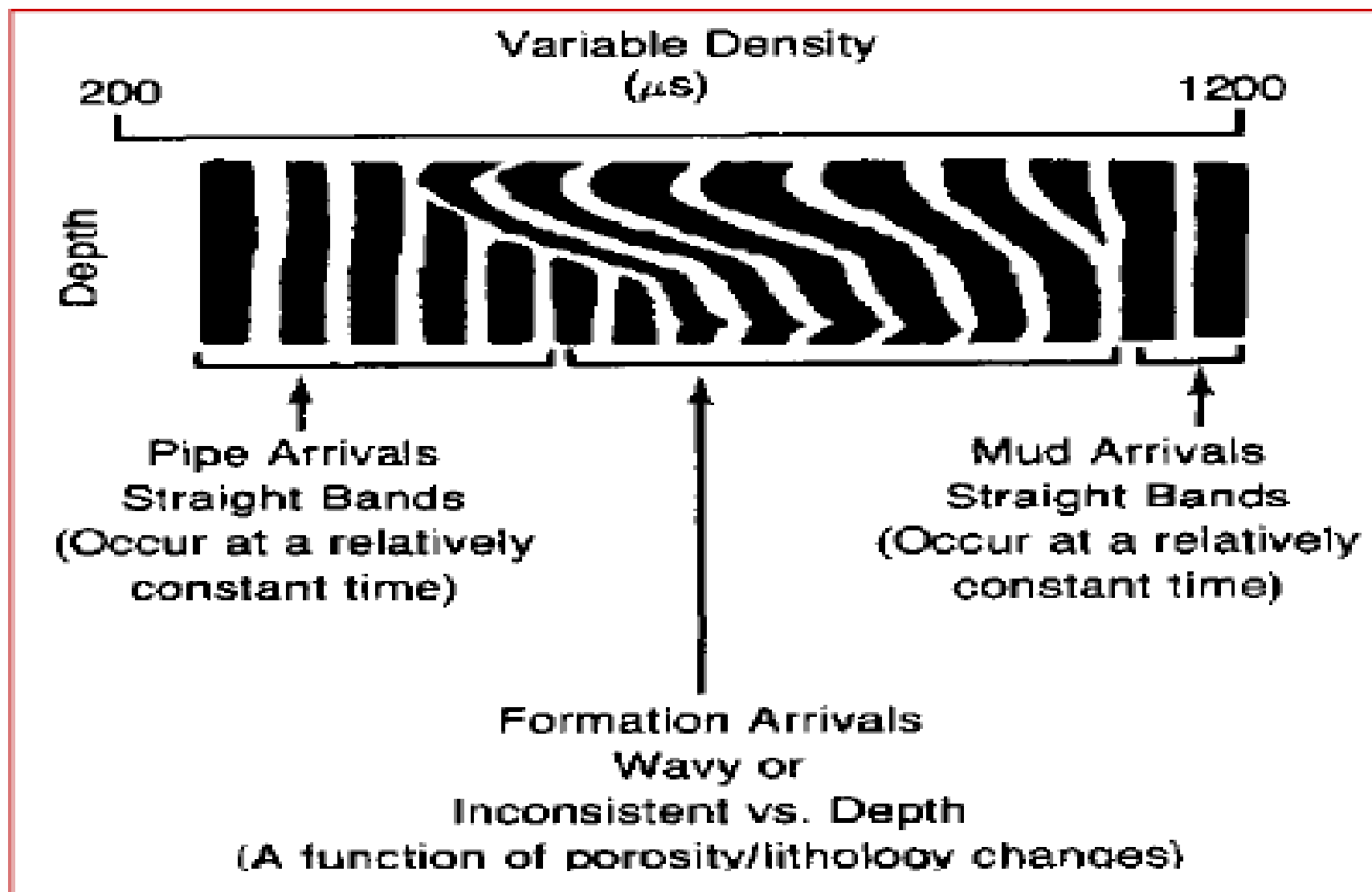
Mud channel



Gas invasion

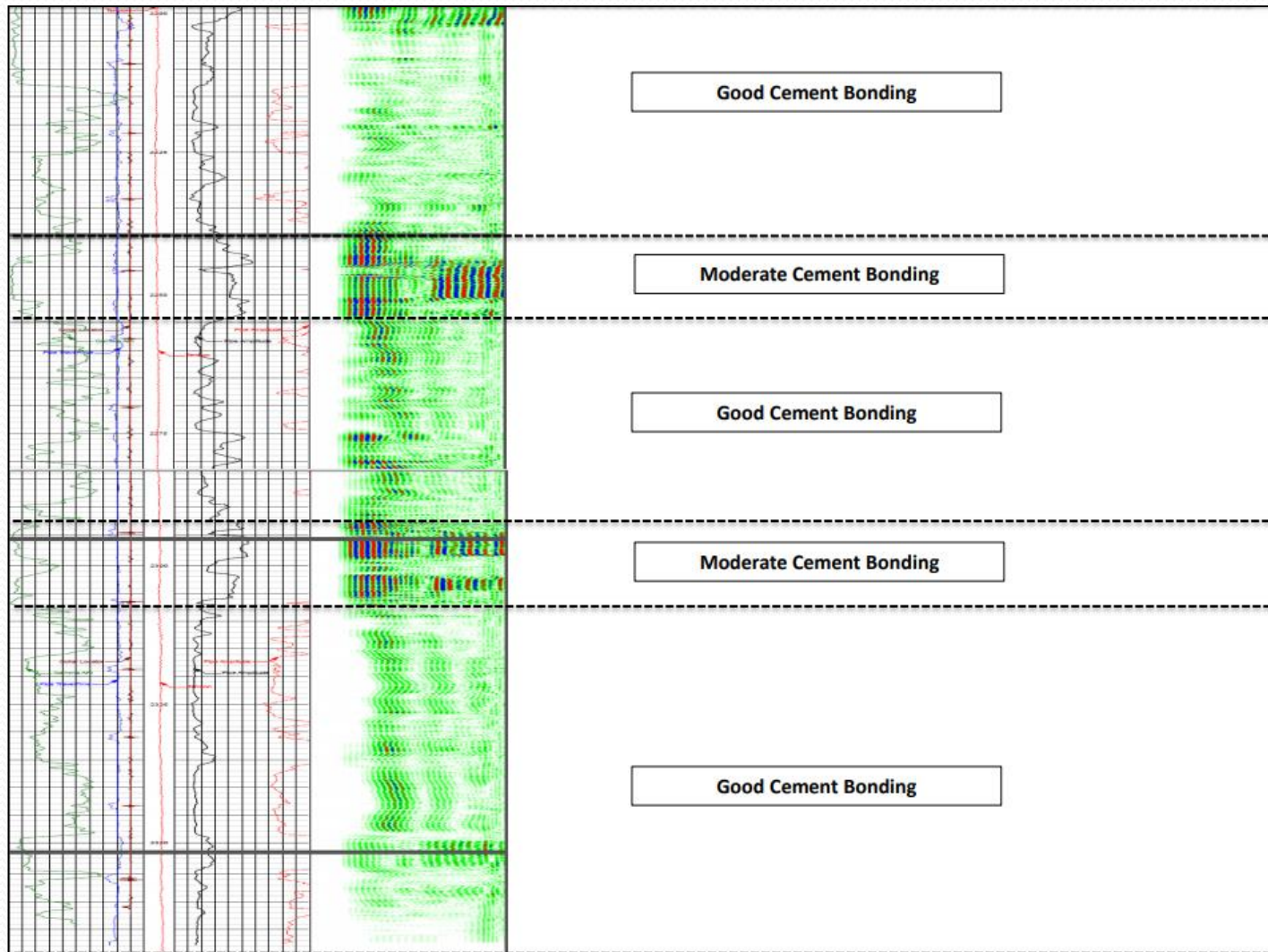
CBL-VDL PRINCIPLE



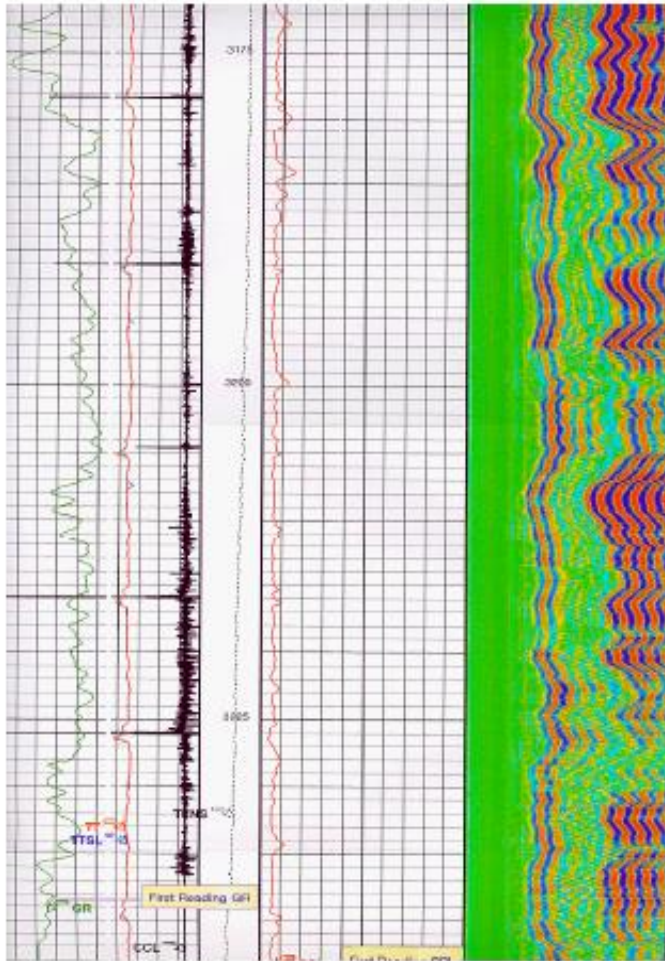


VDL INTERPRETATION

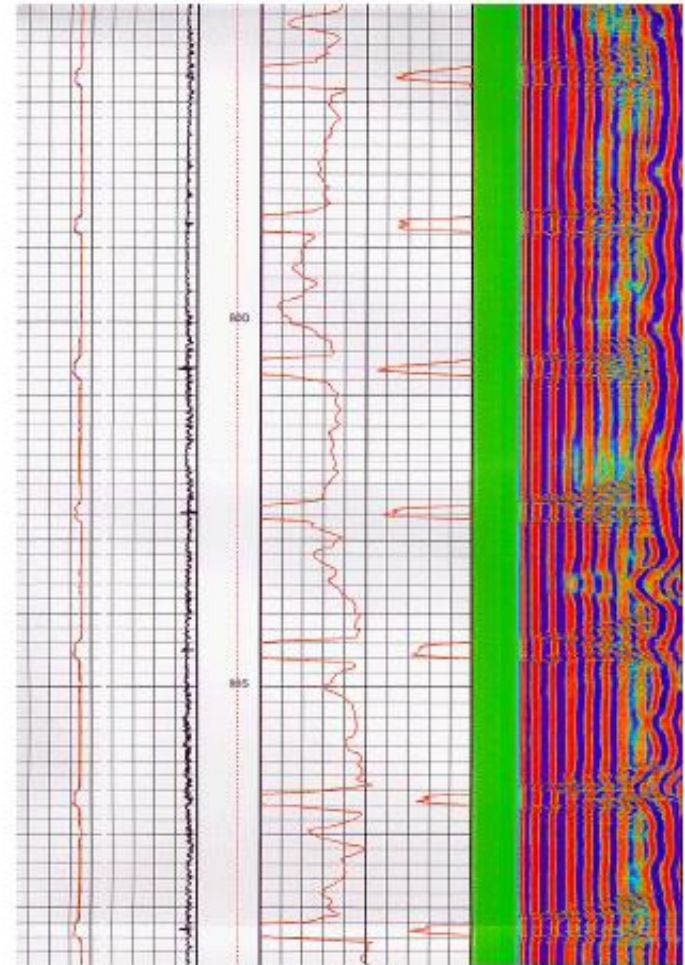
- The CBL trace primarily provides information on the integrity of the casing to cement bond quality.



LOG EXAMPLES

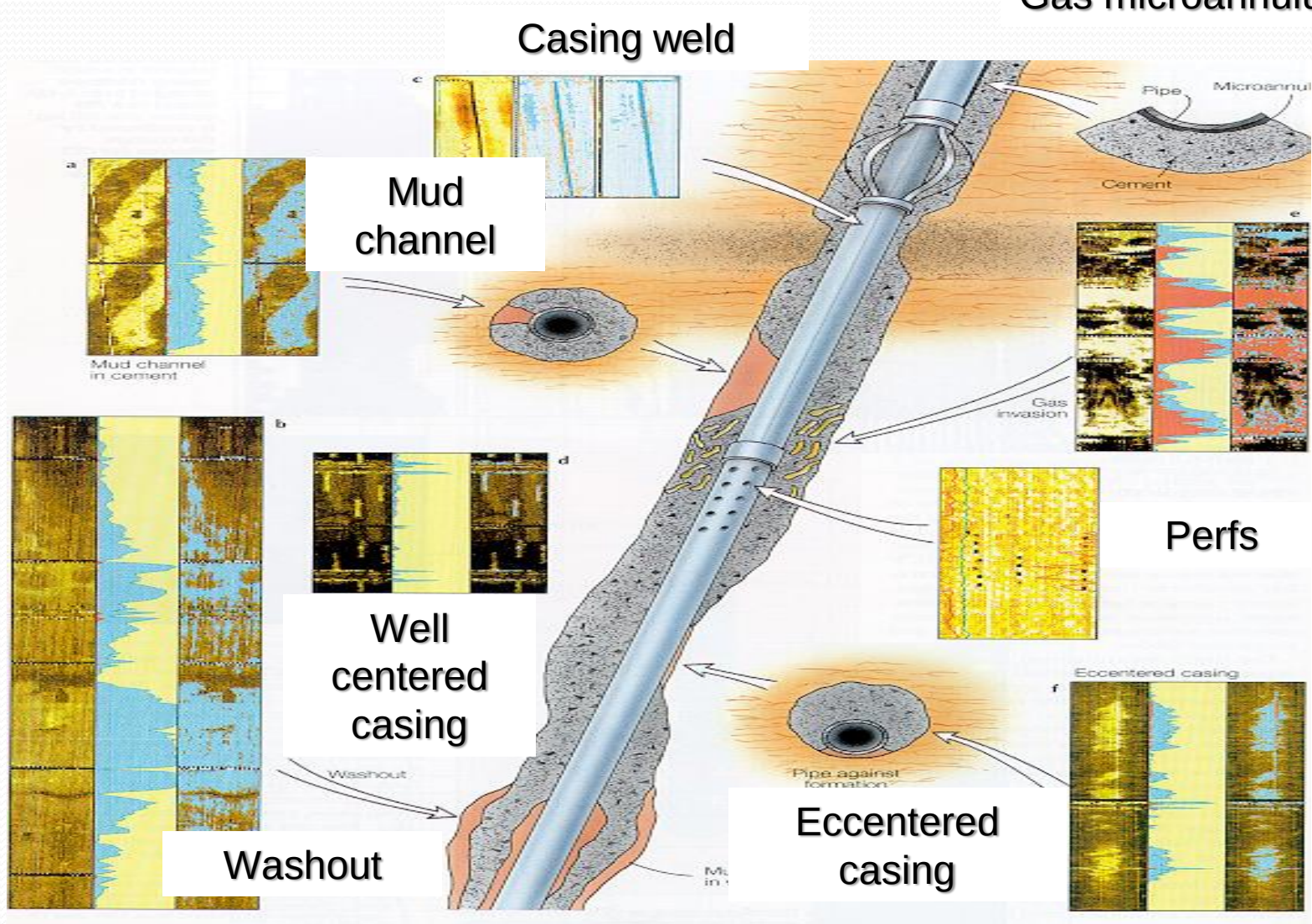


Good bond



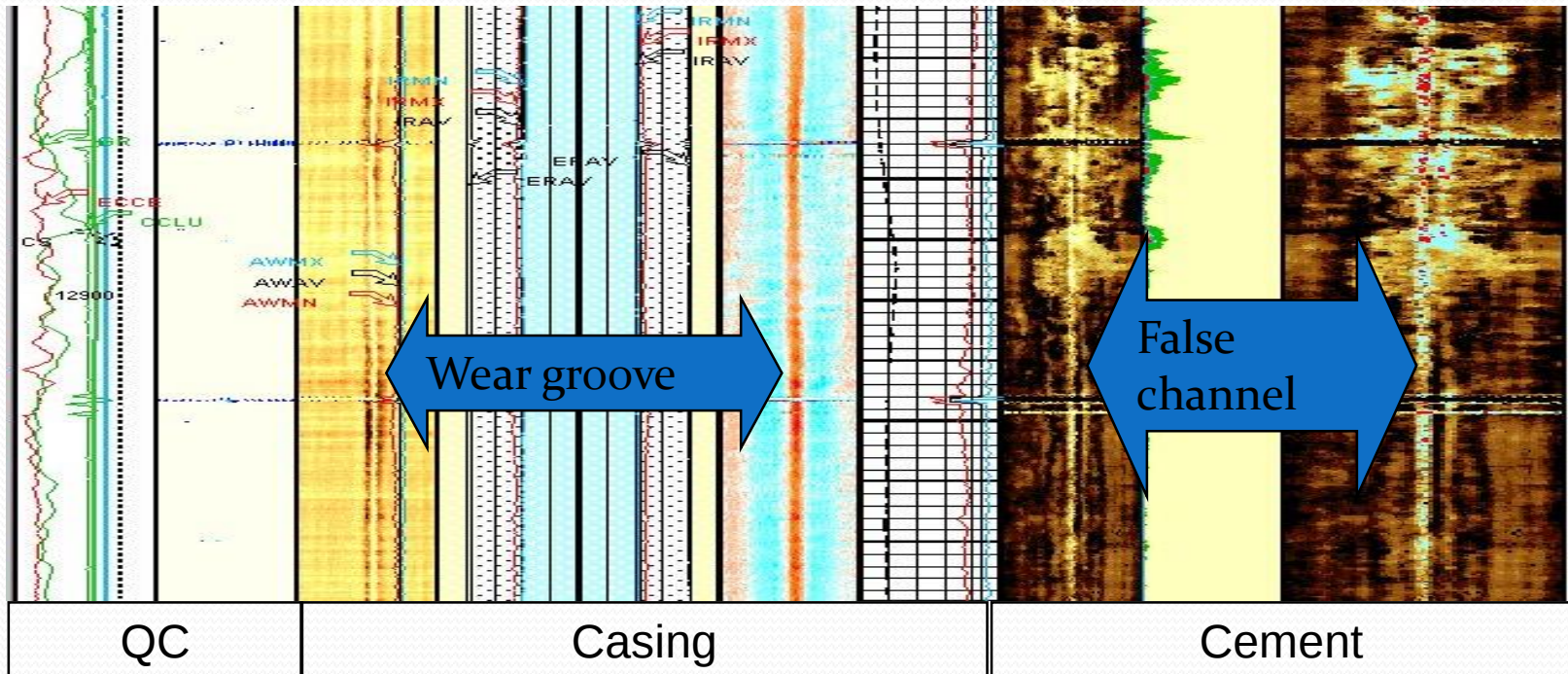
No bond

Gas microannulus

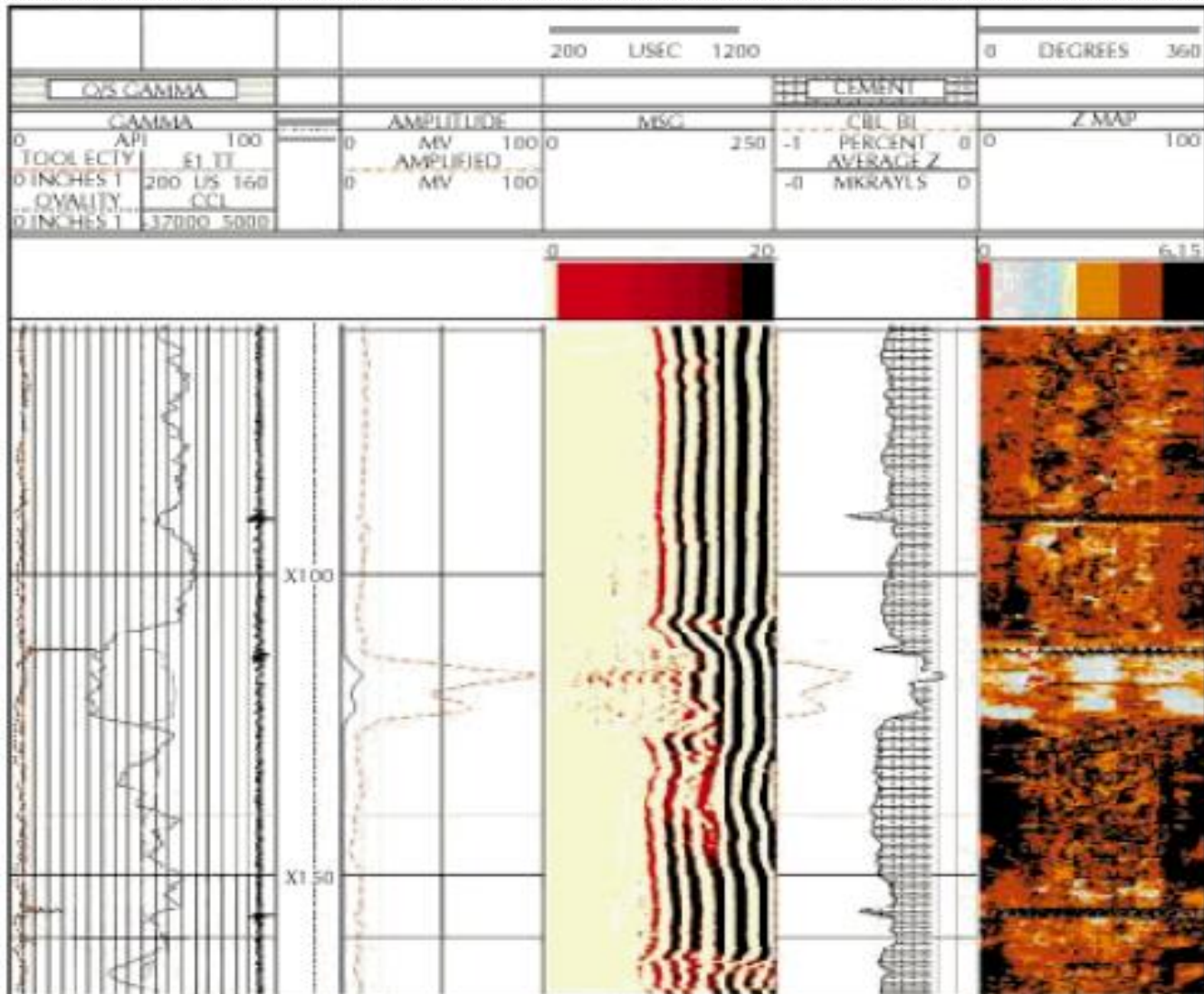


Casing wear can affect cement image

Drill pipe wear creates false “channel”

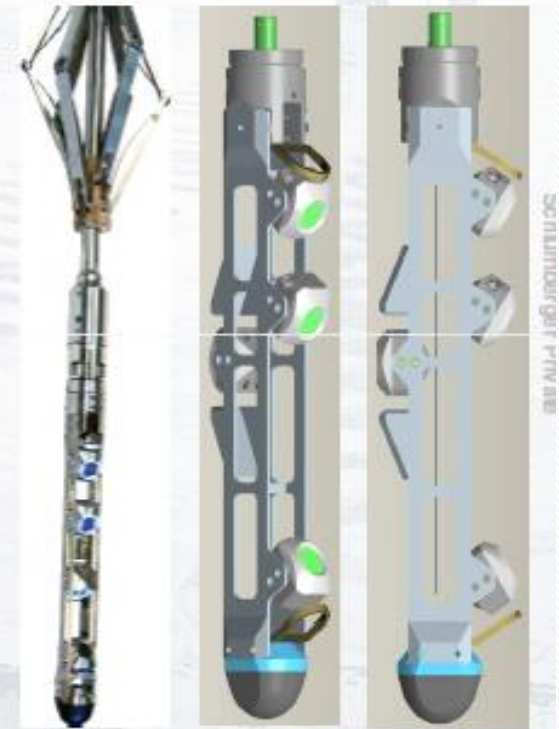


Zone of Poor Cement Bond



Isolation Scanner

- Service built on USI* UltraSonic Imager hardware
 - New Sub design and cartridge modifications
- Combines USI* measurement with a second measurement of *flexural attenuation*
 - Improved evaluation of lightweight and contaminated cements
 - Cement evaluation up to 20-mm [0.79-in] casing thickness
- Enhancement
 - Circumferential imaging, up to formation or second casing



A new Technology To Evaluate Light and Contaminated Cements

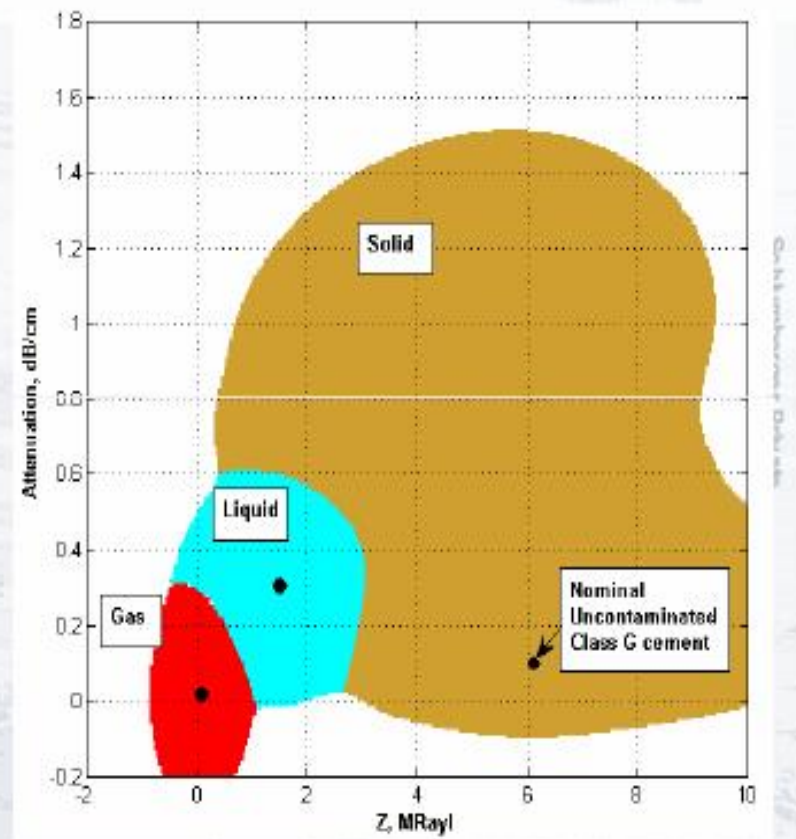
Material Identification in the Annulus

Traditional ultrasonic methods

- Determine acoustic impedance and set **thresholds** to discriminate between solid, liquid, and gas (SLG)

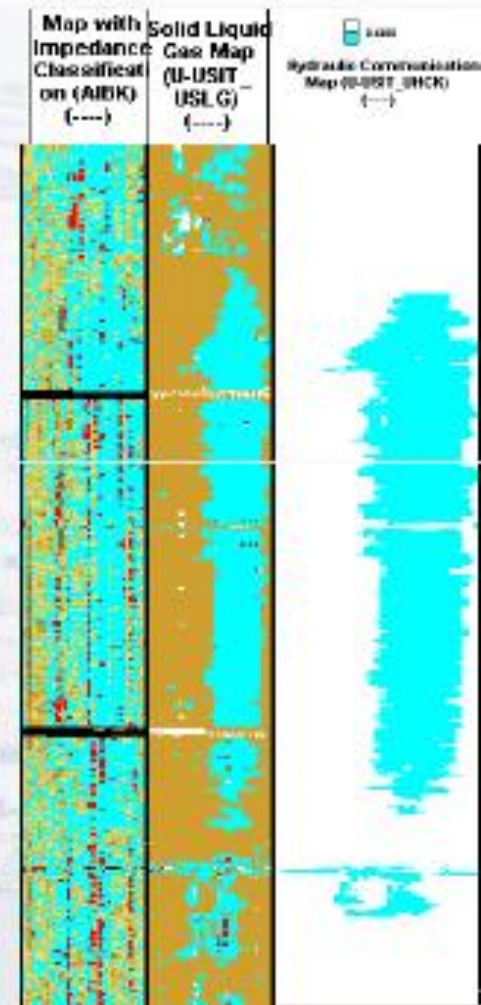
Isolation Scanner* service

- **Map** independent measurements to define annulus material in 1 of 3 SLG states, limiting reliance on thresholds
- Determining key fluid properties through combination of 2 independent measurements



Flexural Attenuation Added

- Simplified picture via SLG Map
- Identifies significant channels in Hydraulic Communication Map
- Displays measured channel width



TUBULAR INTEGRITY

SOURCES OF CORROSION

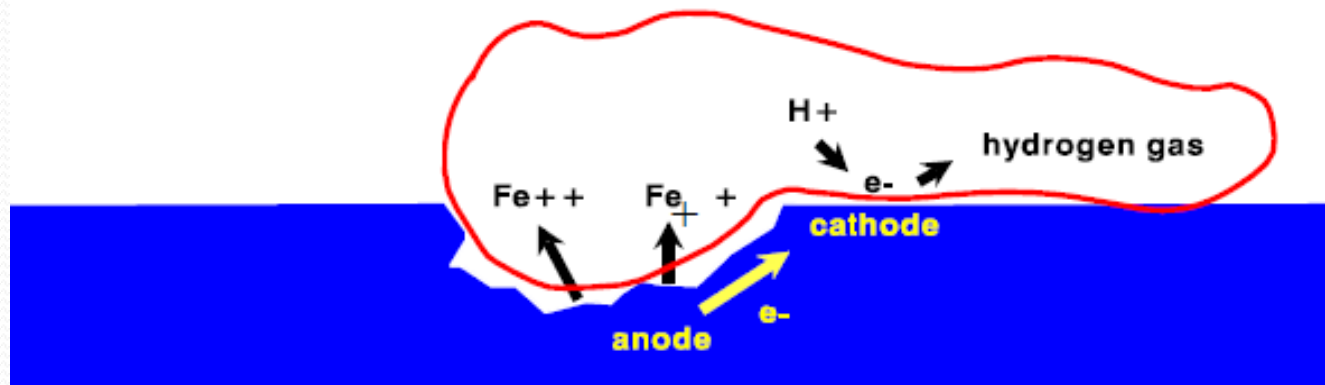
IN PRESENCE OF WATER:

- Carbon Dioxide
- Hydrogen Sulfide
- Oxygen
- Bacteria
- Mechanical Damage

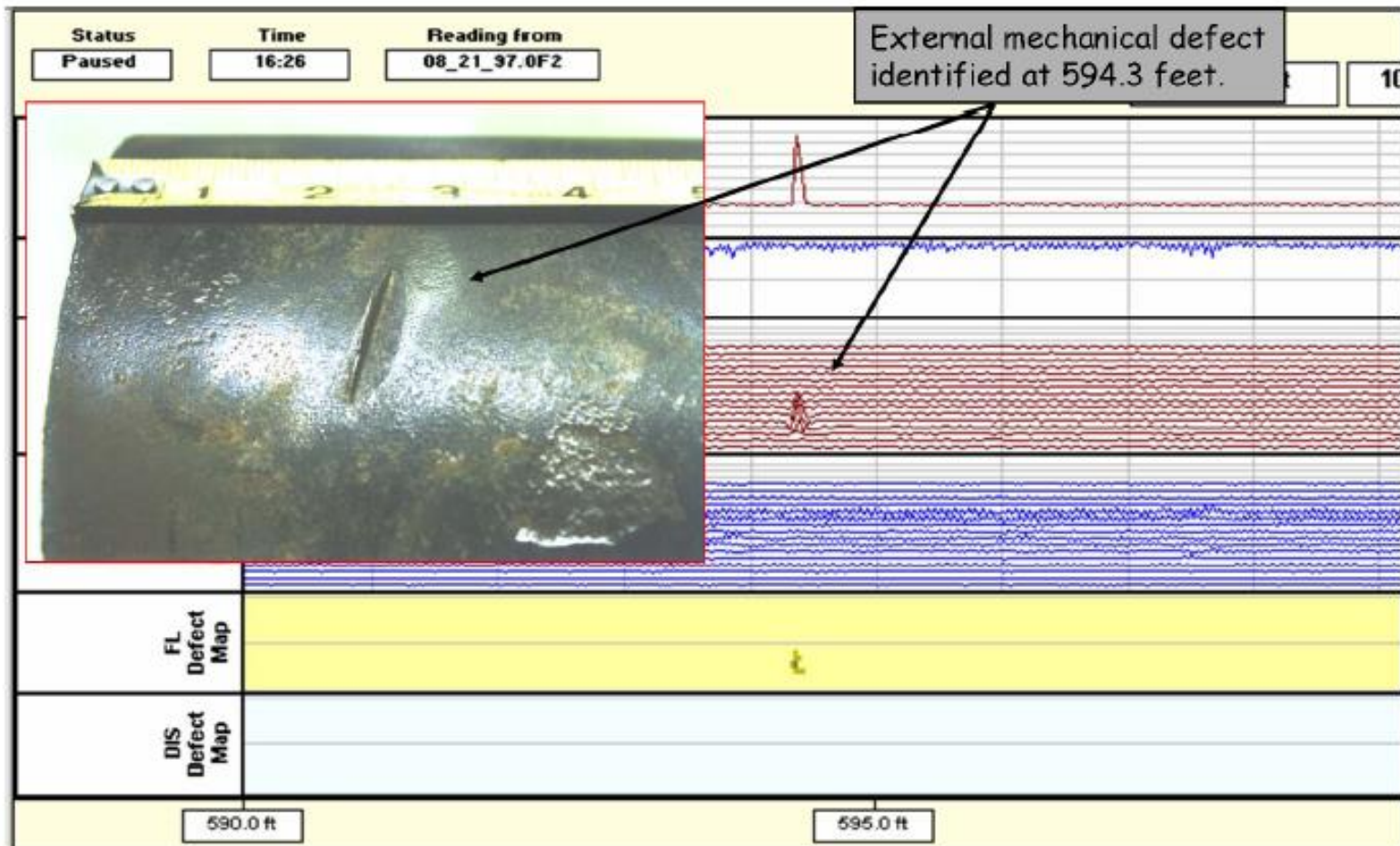


SOURCE OF CORROSION

The electrolyte is the water which surrounds and fills the corrosion cell. It contains the ions that act and react with the metal.



ELECTROLYSE



LOG INTERPRETATION EXAMPLE

Neutron Logs

Neutron cased hole uses

- ✓ For modern tools the neutron tool response indicates a similar neutron porosity to that measured when the same tool is run in open hole.
- ✓ Differences in response will be caused by washouts and the integrity of the cement bond.

Main uses:

- ✓ Porosity information where open hole data is missing.
- ✓ Formation boundaries.
- ✓ Gas detection.

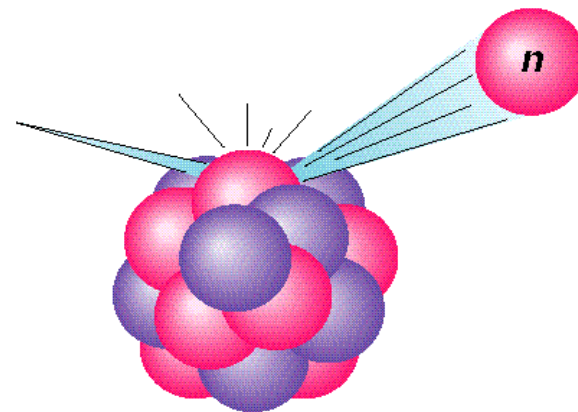
Three Nuclear Interactions

1. Elastic Scattering

The Neutron bounces off the nucleus of an element in the formation

- The nucleus does not destabilize.
- The Neutron loses energy.

Elastic Neutron Scattering



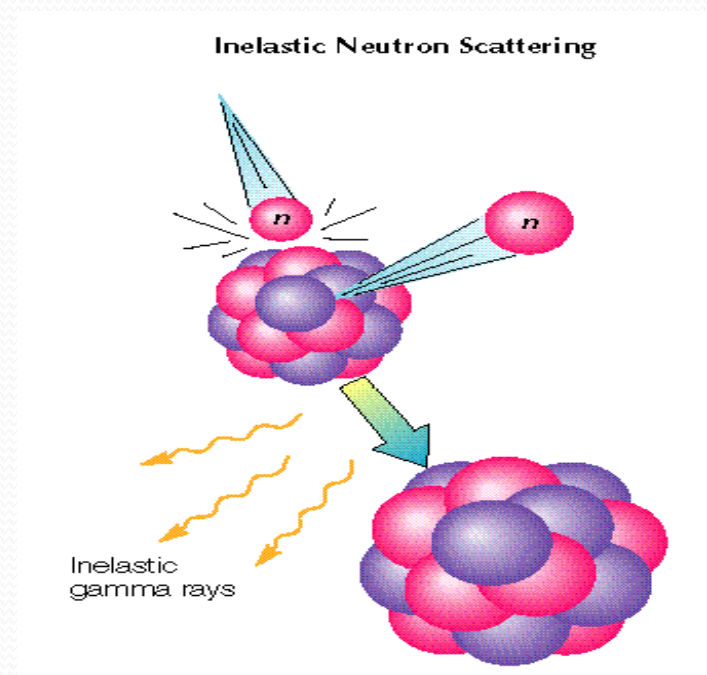
How quickly neutrons slow down indicates the Porosity

Three Nuclear Interactions

2. In-elastic Scattering

The Neutron bounces off the nucleus of an element in the formation.

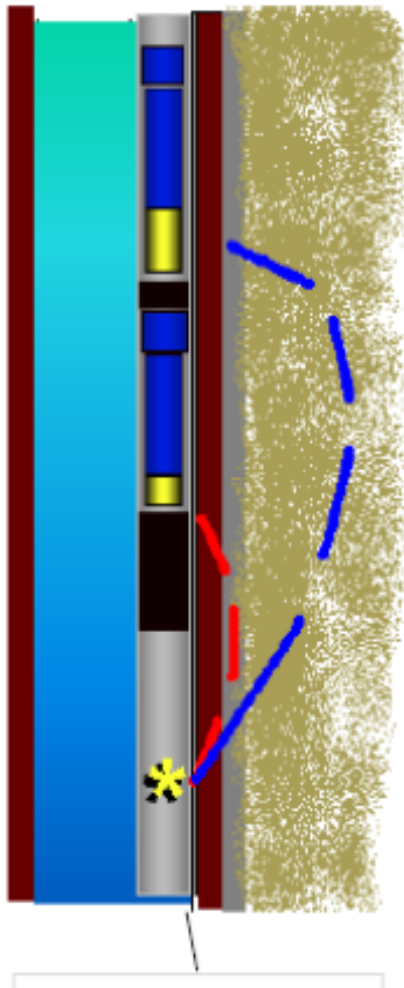
- The nucleus destabilizes.
- Gamma Rays are quickly given off.



- All Elements give off characteristic Inelastic gamma rays
- Measuring these yields the concentrations of Carbon and Oxygen

C/O Ratio => Oil Saturation

Carbon/Oxygen logging



PRINCIPLES

- The source emits a burst of fast neutrons into the borehole with energy of 14 MeV, activating nuclei like Oxygen & Carbon
- The inelastic high energy Gamma Rays arise from interactions between these high energy neutrons and atoms of the wellbore and formation near the source
- The energy spectrum of these inelastic GR is measured during the neutron burst, together with the spectrum of capture GR

APPLICATIONS

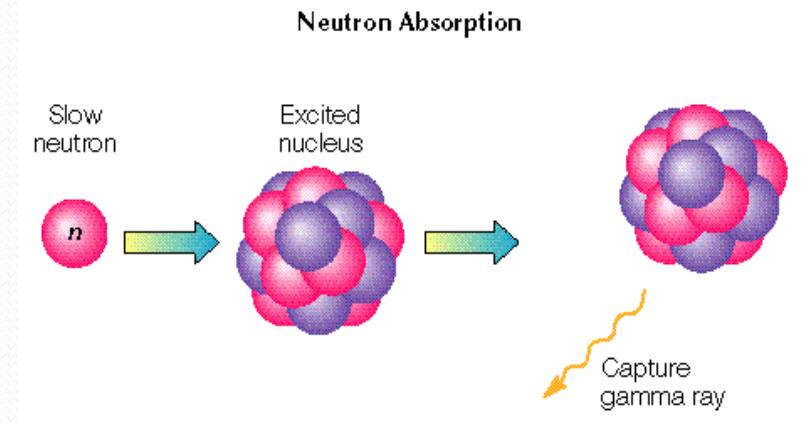
- Determination of water saturation and fluids' contacts in oil fields when salinity of formation water is low or unknown
- Locate water and oil zones in water floods where mixed salinity exist between formation and flood water
- Capability of evaluating relative elements yields of C, O, Ca, Si, Fe, S, H and Cl for both fluid and mineralogical characterization of the reservoir.

Three Nuclear Interactions

3.Absorption

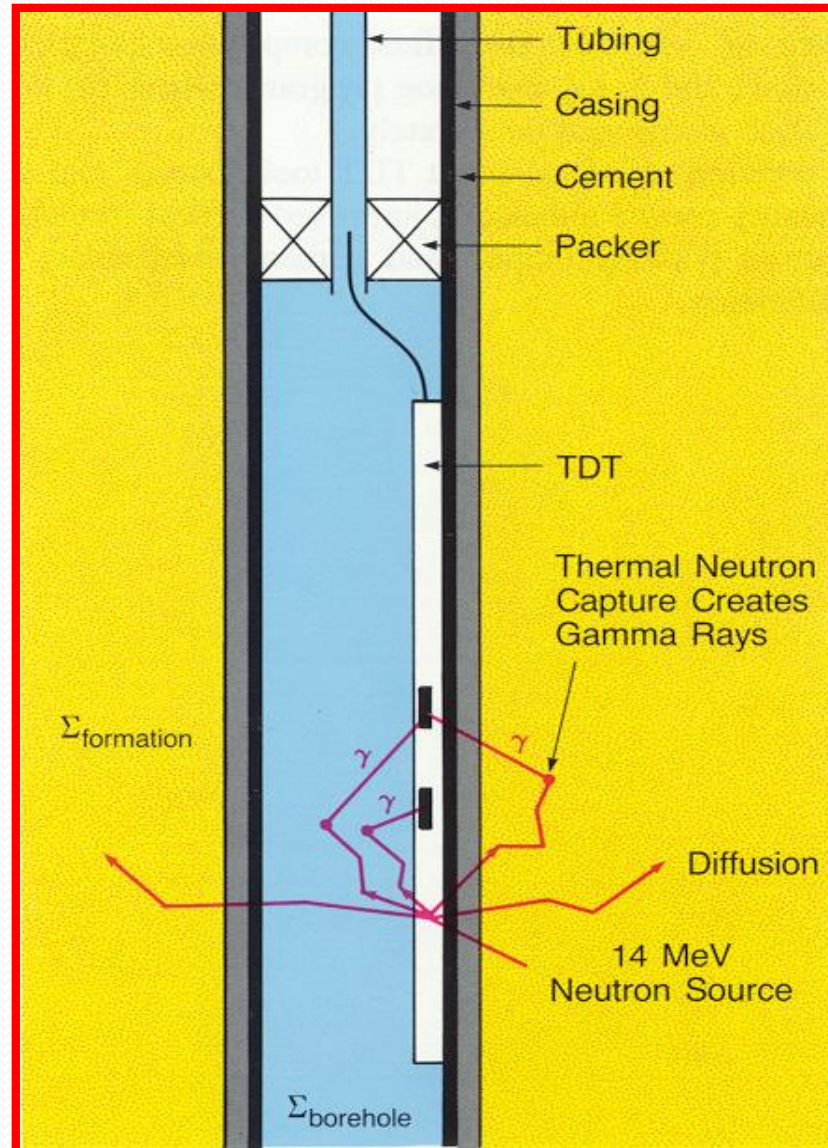
The Neutron enters the nucleus of an element in the formation

- The neutron is at thermal energy
- The nucleus destabilizes
- Gamma Rays are given off

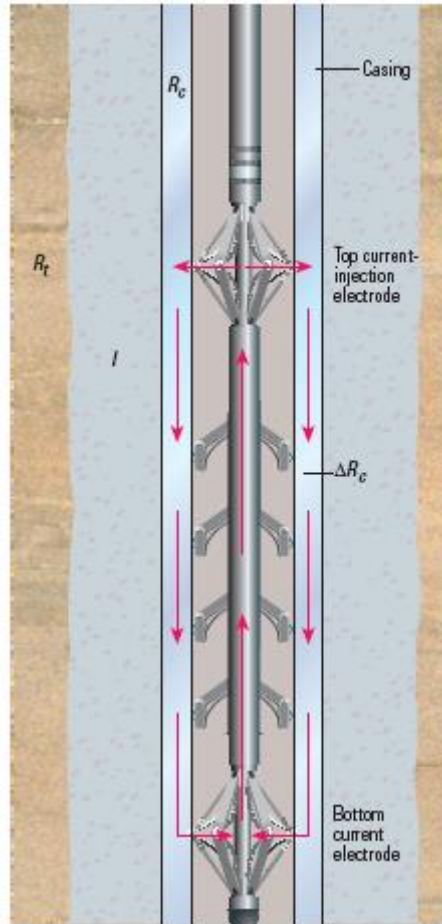


- All Elements give off characteristic Capture gamma rays.
- Measuring energies indicates the Lithology
- Counting vs time gives SIGMA a measure of apparent Salinity

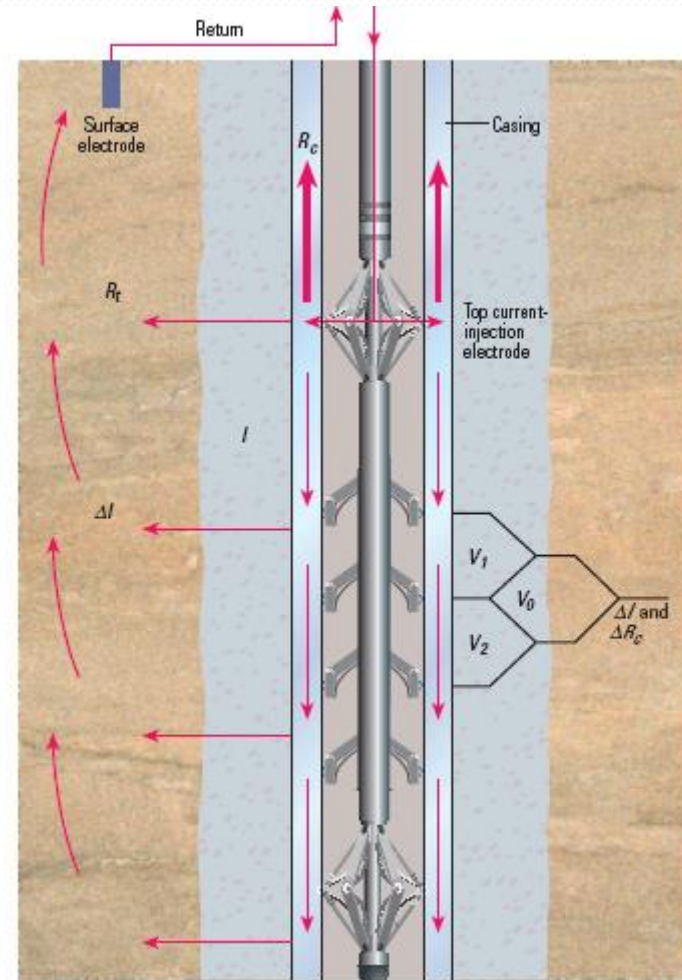
Pulsed Neutron Capture (PNC)



CASED HOLE RESISTIVITY



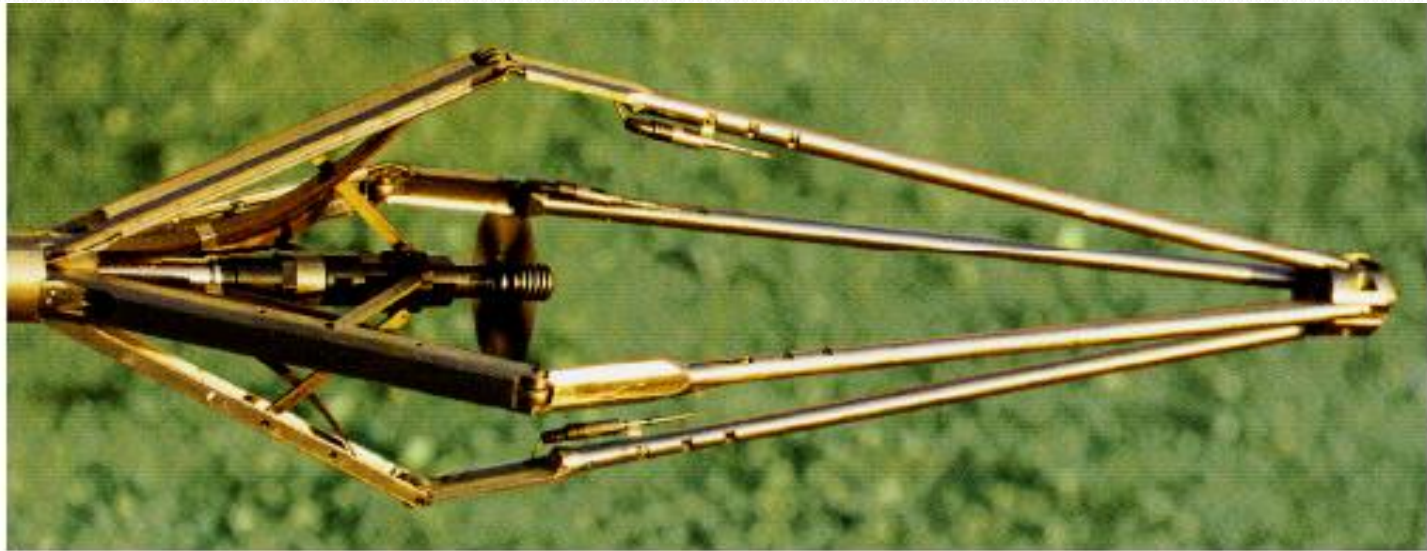
Calibration Step
– Resistivity of the casing is measured



Measurement Step – A/C current applied
Majority flows up pipe to surface
Some flows down pipe & out through formation



Production Logging Tool (PLT)



Four arms caliper and spinner flowmeter



Fullbore Spinner
3-arm



Fullbore Spinner
6-arm



Continuous
Spinner



Continuous Spinner
Jewelled

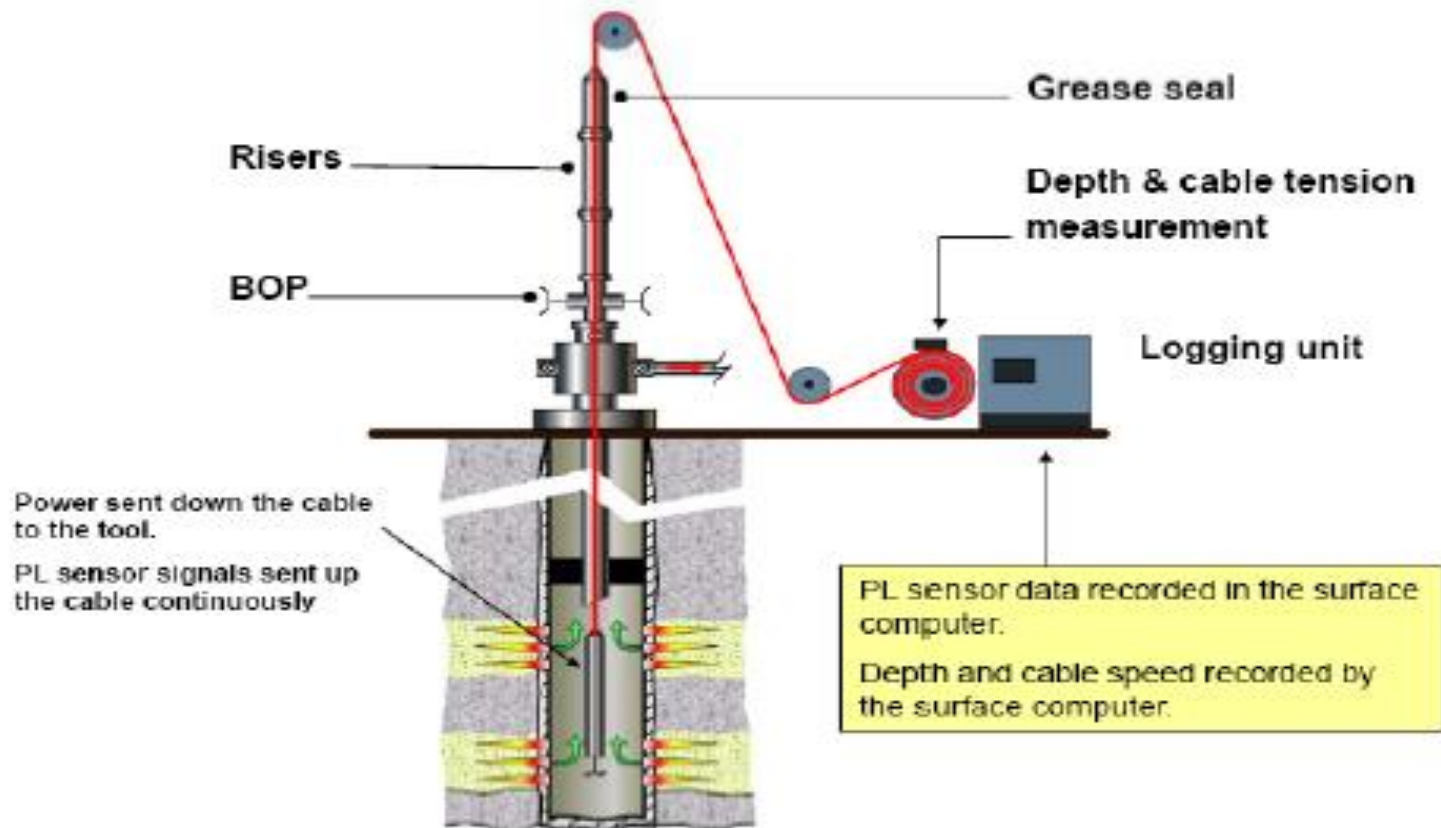


In-line Spinner

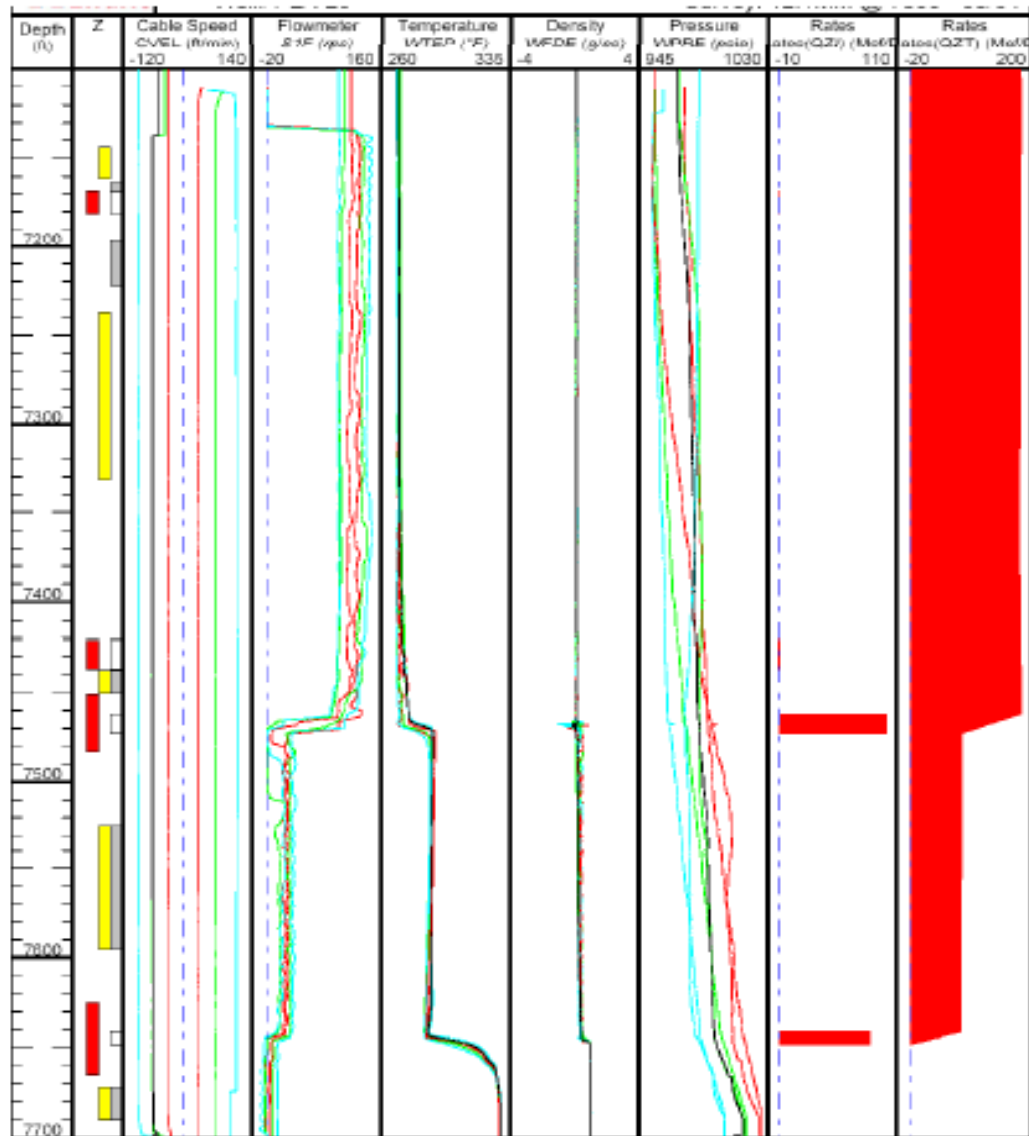


Diverter
Flowmeter

PLT Tool Logging (Surface Read out)



It can be run in memory mode with a slick line unit
(Cheaper but no log quality control)



2 Gas producing levels

- Temperature decreasing
(gas expansion)

- 0.15 g/cc Gravity

