Lecture Two

Formation Evaluation

Petroleum & Mining Engineering Collage

Reservoir Engineering Department / Third Year

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Mud Logging Unit

What Is Mud Logging Unit?

The mud logging unit *is the* ***information center*** *on the rig site to serve both exploration and drilling. It is located very close to the rig floor.*

There are many ***sensors*** are used to measure many important variables or parameters of the rig operations.

Mud Logging Unit

What are the sensors that feel all parameters in mud logging operations?

- Stand Pipe Pressure Sensor (SPP).
- Casing Pressure Sensor.
- Rotary Speed.
- Mud Flow out.
- Mud temperature, Weight and Conductivity.
- Hydrogen Sulfide H_2S Sensor.

Mud logging sensors

Drilling fluid density sensor

Pressure Sensor

Drilling Fluid Conductivity Sensor

Mud Flow-out Sensor

Mud Temperature Sensor

H2S SENSOR

Mud Logging Information

To comprehend all of the information available, we need to understand *four important areas of mud logging*

01 Rate of Penetration and Lag

02 Gas Detection

03 Formation Evaluation and Sample Collection

04 Hydrocarbon Show Evaluation

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Rate of Penetration

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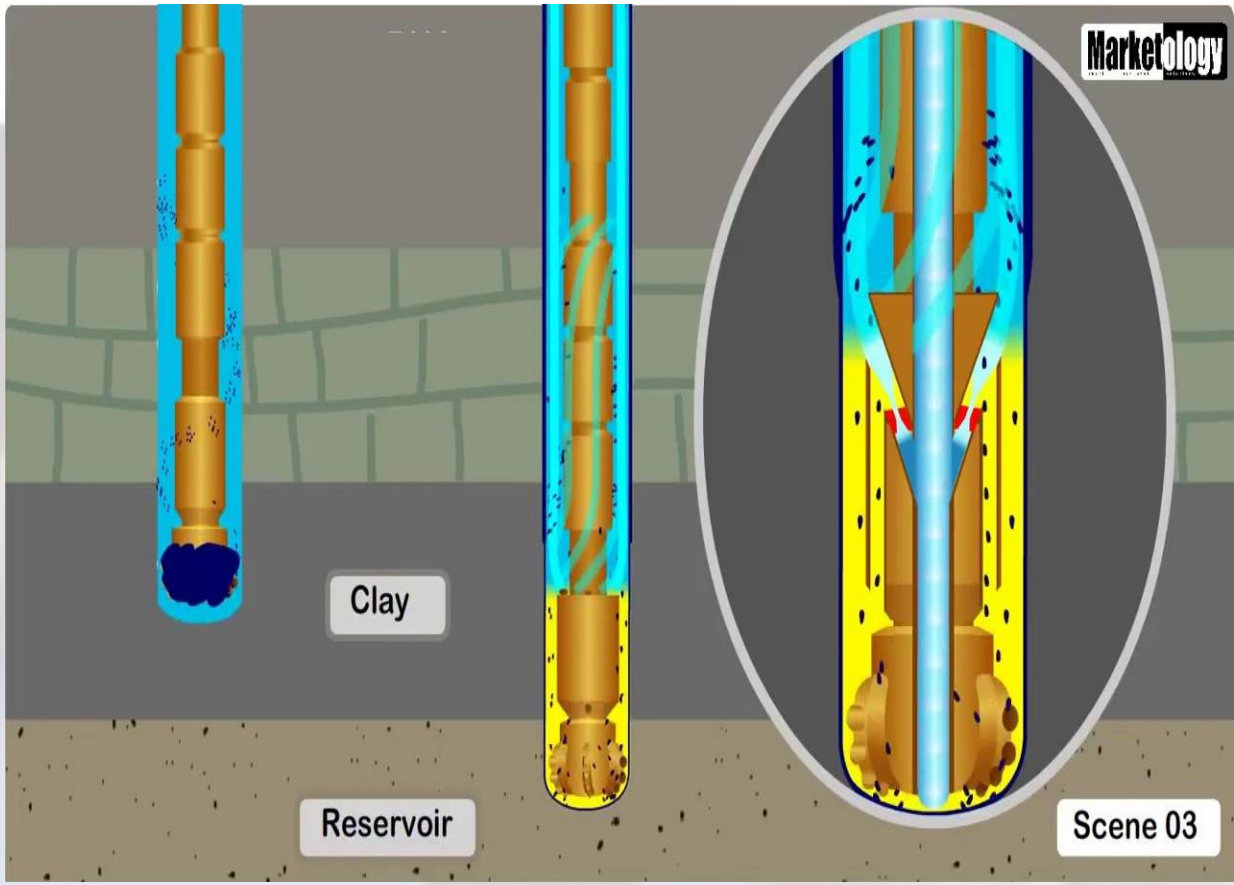
Rate of Penetration and Lag

The speed at which the drill bit can break the rock under it and thus deepen the wellbore. This speed is usually reported in units of ft/hr or m/ hr.



ROP Influenced by the **formation's lithology** (rock type and hardness), **porosity, and pressure**.

Factors Affecting Penetration Rate (ROP):

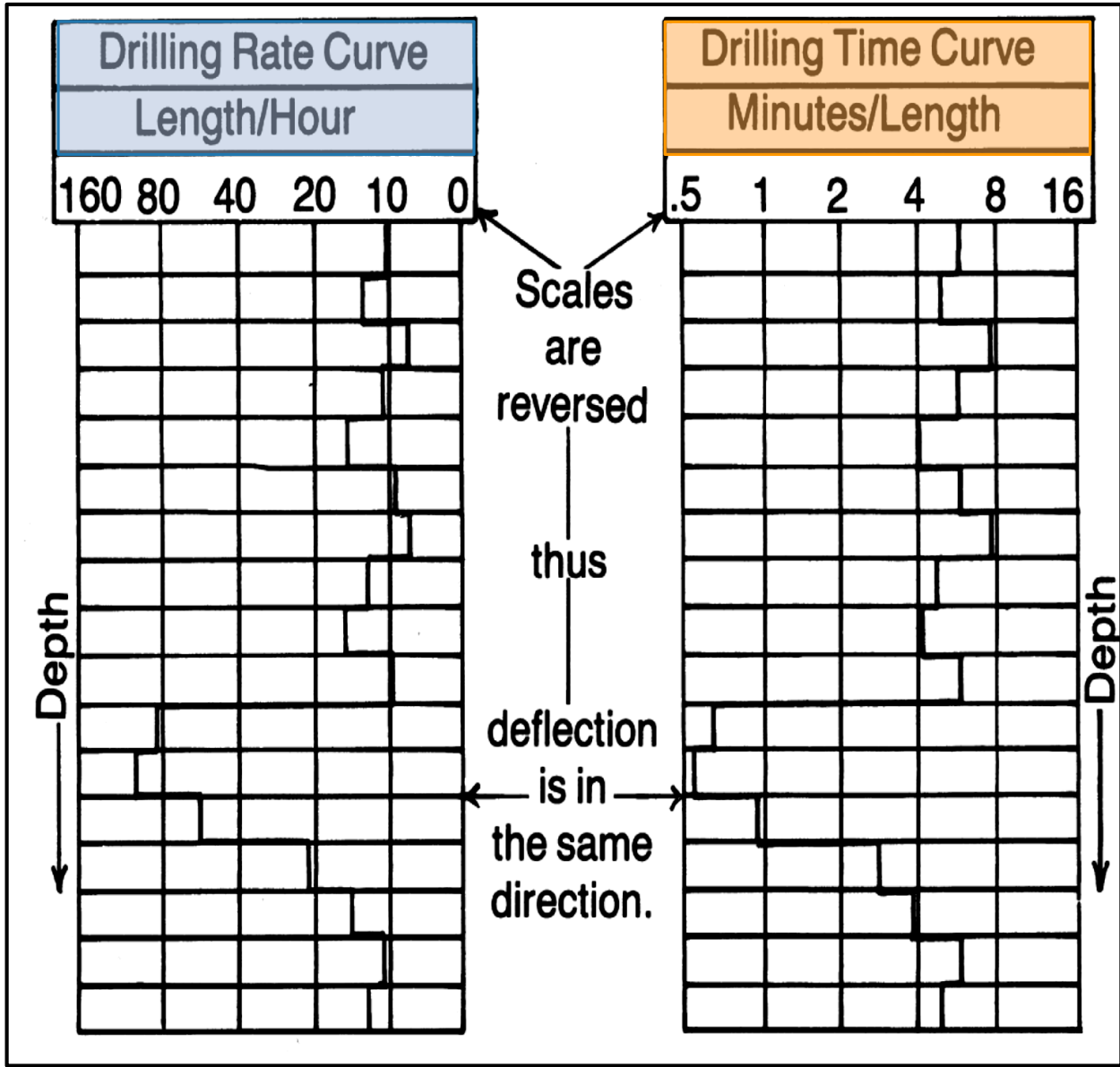
Enviromental Factors	Controllable Factors
Depth	Bit Wear State
Formation Properties	Bit Design
Mud Type	Weight on Bit
Mud Density	Rotary Speed
Other Mud Properties	Flow Rate
Overbalance Mud Pressure	Bit Hydraulic
Bottom hole Mud Pressure	Bit Nozzle Size
Bit Size	Motor/Turbine Geometry

Rate of Penetration Curves

The rate of penetration represents as a plot of ROP vs. depth.

If ROP is expressed in units of ***length/hr****, its curve is called a* ***drilling rate curve.***

When the units are in ***min/length****, the curve is referred to as a* ***drilling time curve.***



Lag and Drilling Break

Lag Time

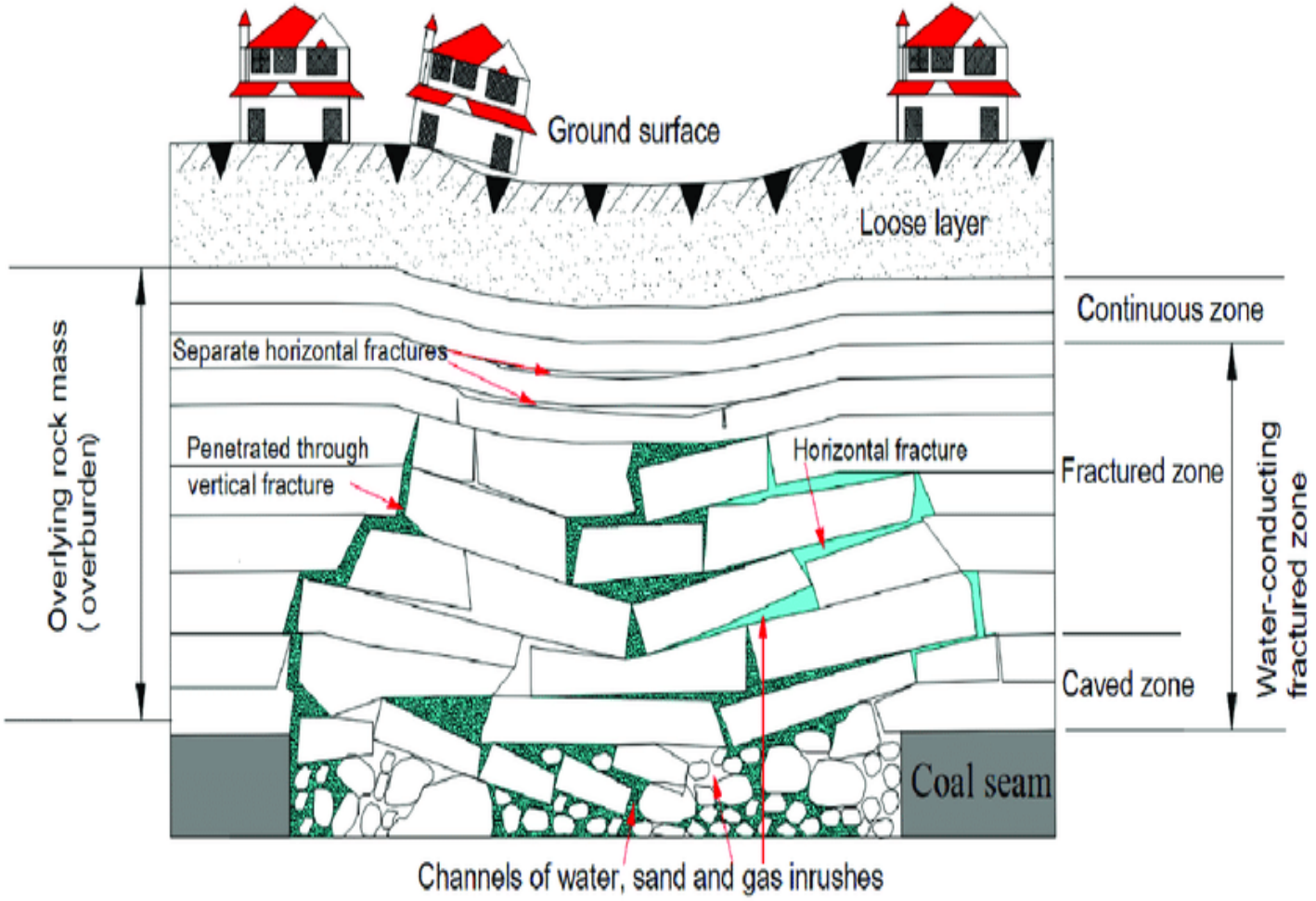
is defined as the time required for drilling fluid, gas, or cuttings traveling from the bottom-hole to the surface through the wellbore annulus.

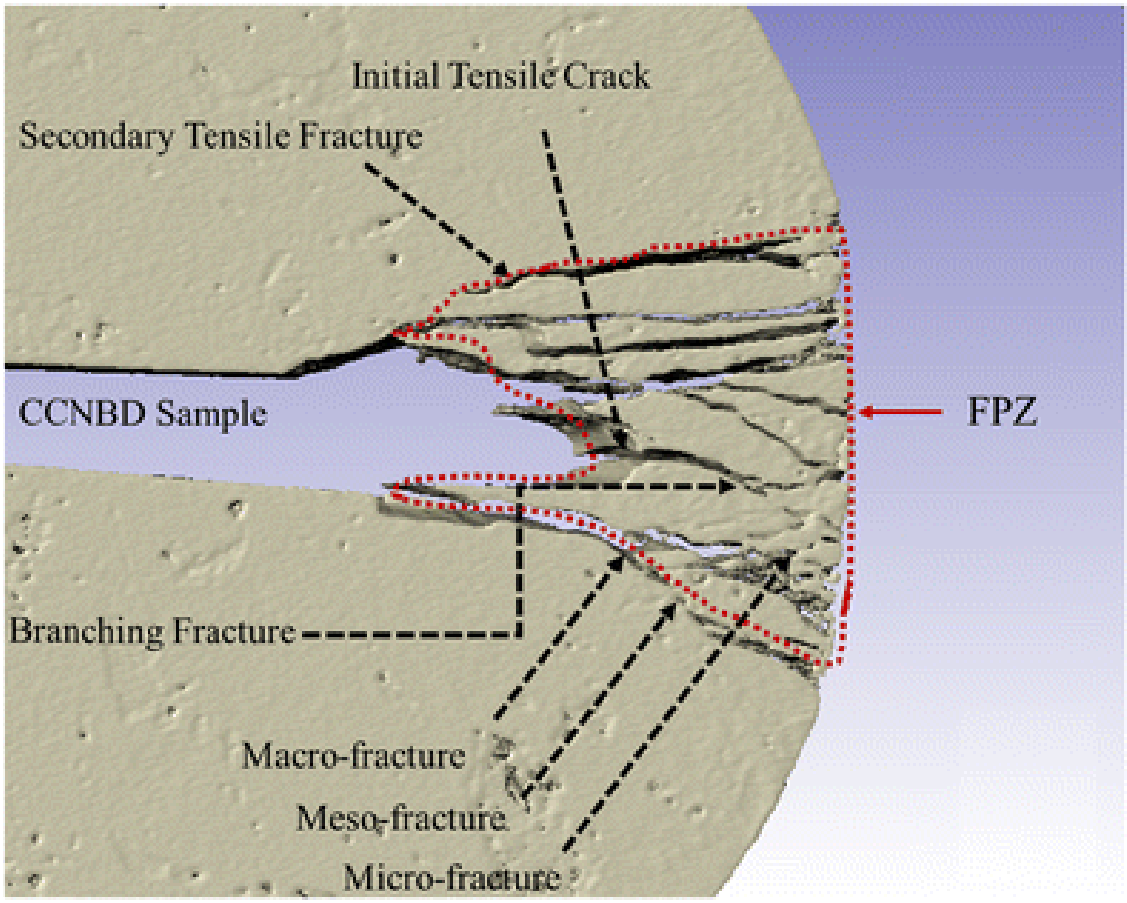
Lag depth

is defined as the formation depth in which the cuttings sampled or collected at the surface originally existed.

Drilling Break

A sudden increase in the rate of penetration during drilling. It usually indicates ***a change in lithology****, although it sometimes is the result of a* ***fractured zone*** *or a* ***poorly consolidated zone****.*


Ground surface
Loose layer
Overlying rock mass (overburden)
Separate horizontal fractures
Penetrated through vertical fracture
Horizontal fracture
Continuous zone
Fractured zone
Caved zone
Water-conducting fractured zone
Coal seam
Channels of water, sand and gas inrushes


Initial Tensile Crack
Secondary Tensile Fracture
CCNBD Sample
FPZ
Branching Fracture
Macro-fracture
Meso-fracture
Micro-fracture

2

Gas Detection

2

Gas Detection

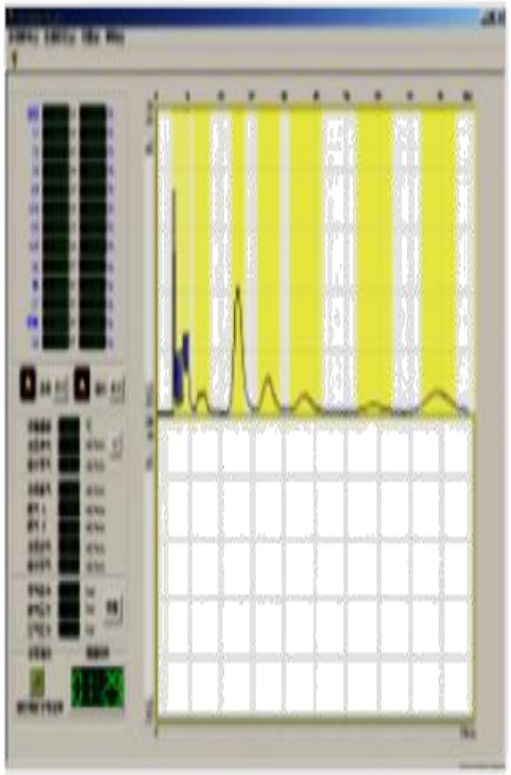
The monitoring of gas, both types and amount, is one of the most critical tasks in mud logging.

A mud logging unit usually contains **two** separate gas detectors, *one for mud (continuous) and one for cuttings (batch)*. Equipment can be included to detect and analyze for H_2S, CO_2, He, etc.

A hot-wire type detector and panel meter are used to indicate the presence of hydrocarbon gases.

Accurate gas data recorded during drilling are of great value in proper reservoir evaluation, and may pinpoint potentially overlooked producing zones.

Gas Chromatography (GC) is the primarily used technique for gas identification and measurement during the mud logging process. The most common component in mud logging well gas is methane; heavier hydrocarbons such as ethane (C2), propane (C3), and butane (C4) may indicate an oil or wet gas zone.



https://www.youtube.com/watch?v=6Z61ezJFfyA

Gas enters the drilling fluid from one of two sources:

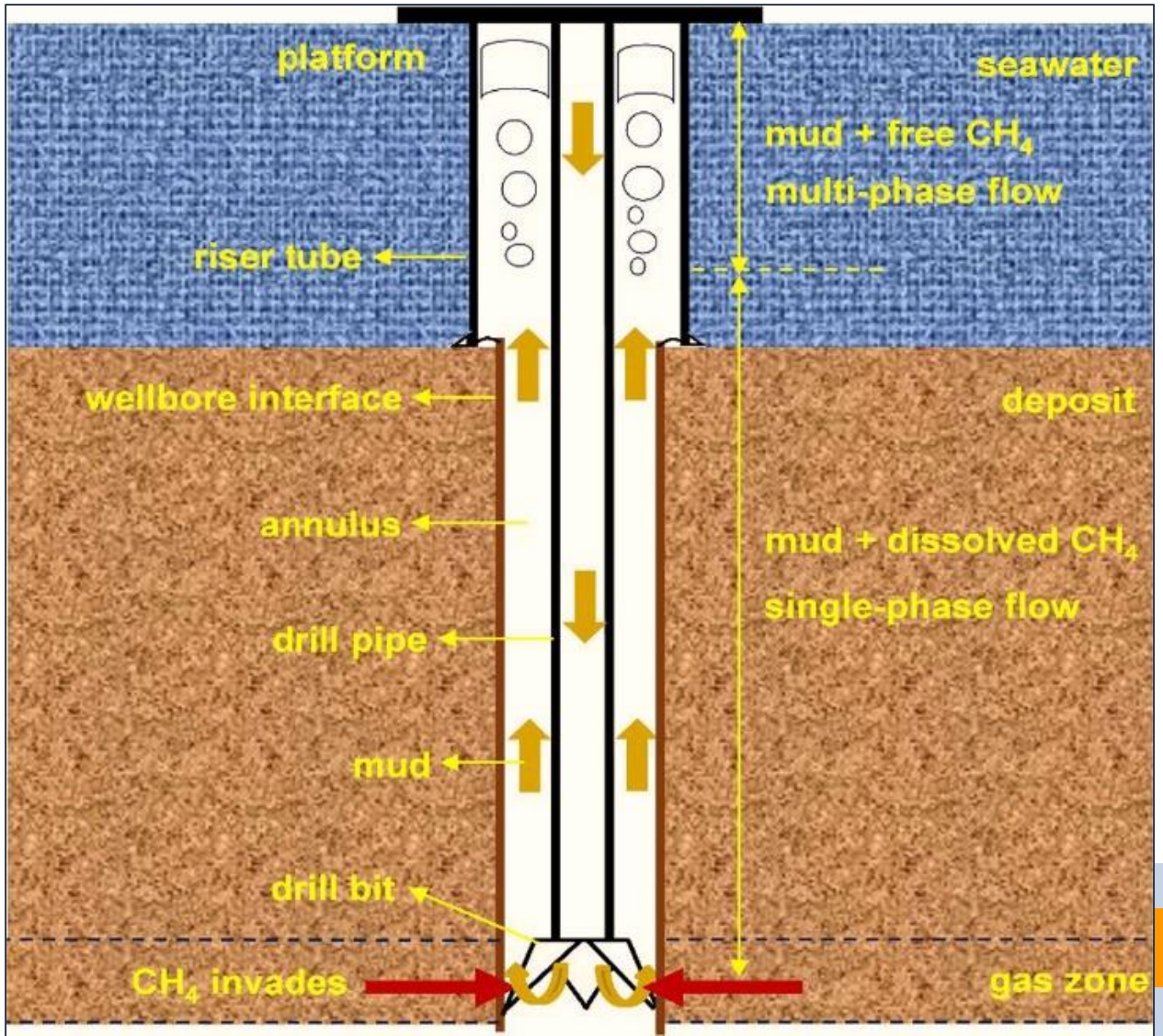
01 A Gas-Bearing Formation

02 Contamination

How is Gas Detected?

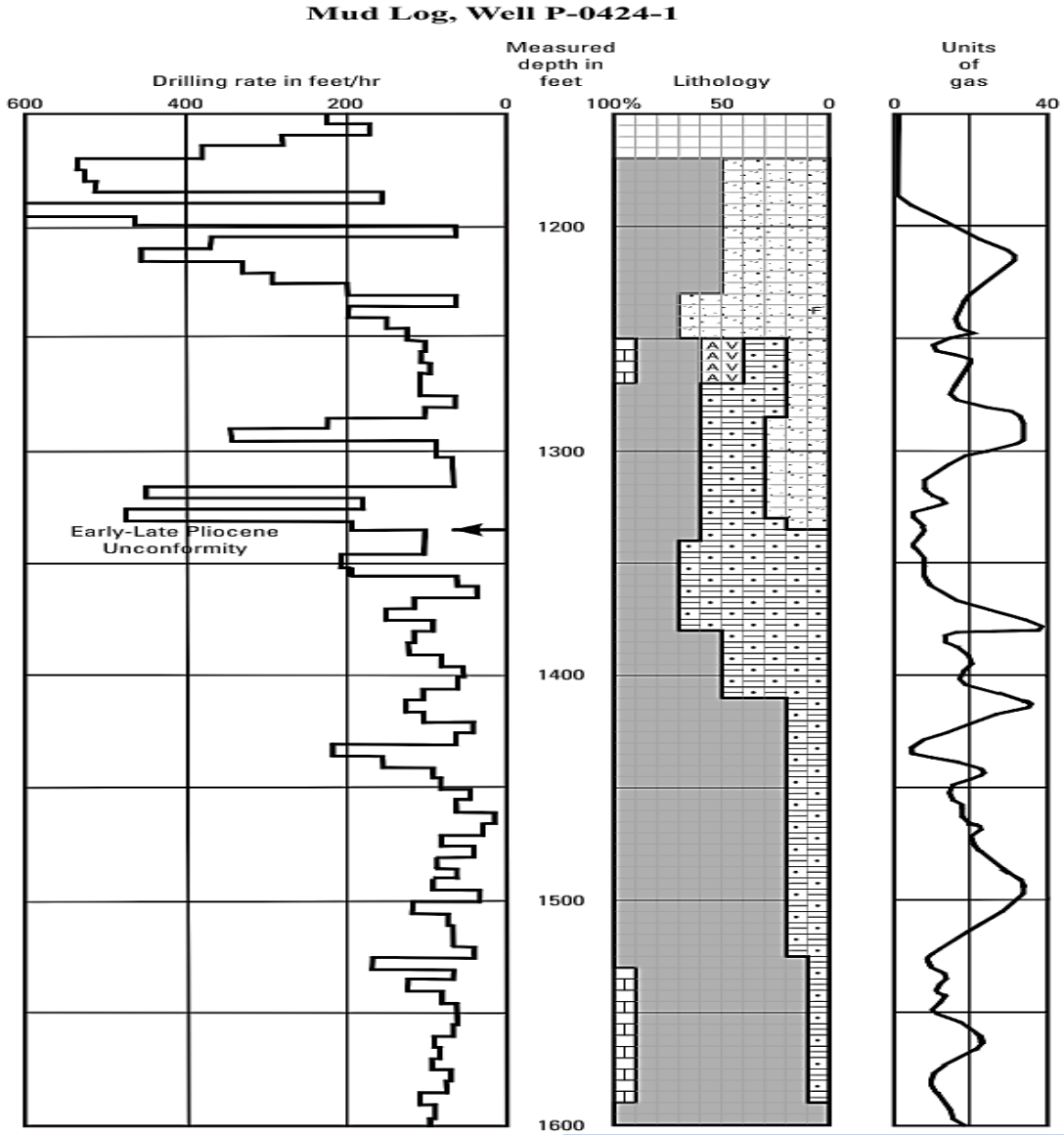
As the bit drills through a formation, it opens or exposes some of the pores. Fluid from these opened pores mixes with the drilling mud.

This gas, along with cuttings, or pieces, from the drilled formation, is pumped back up toward the surface.



The amount of flow from the formation into the borehole depends upon:

- The pressure differential (the difference between the hydrostatic pressure and the formation pressure)
- The porosity and permeability
- The properties of the formation’s fluids.



SYMBOLS

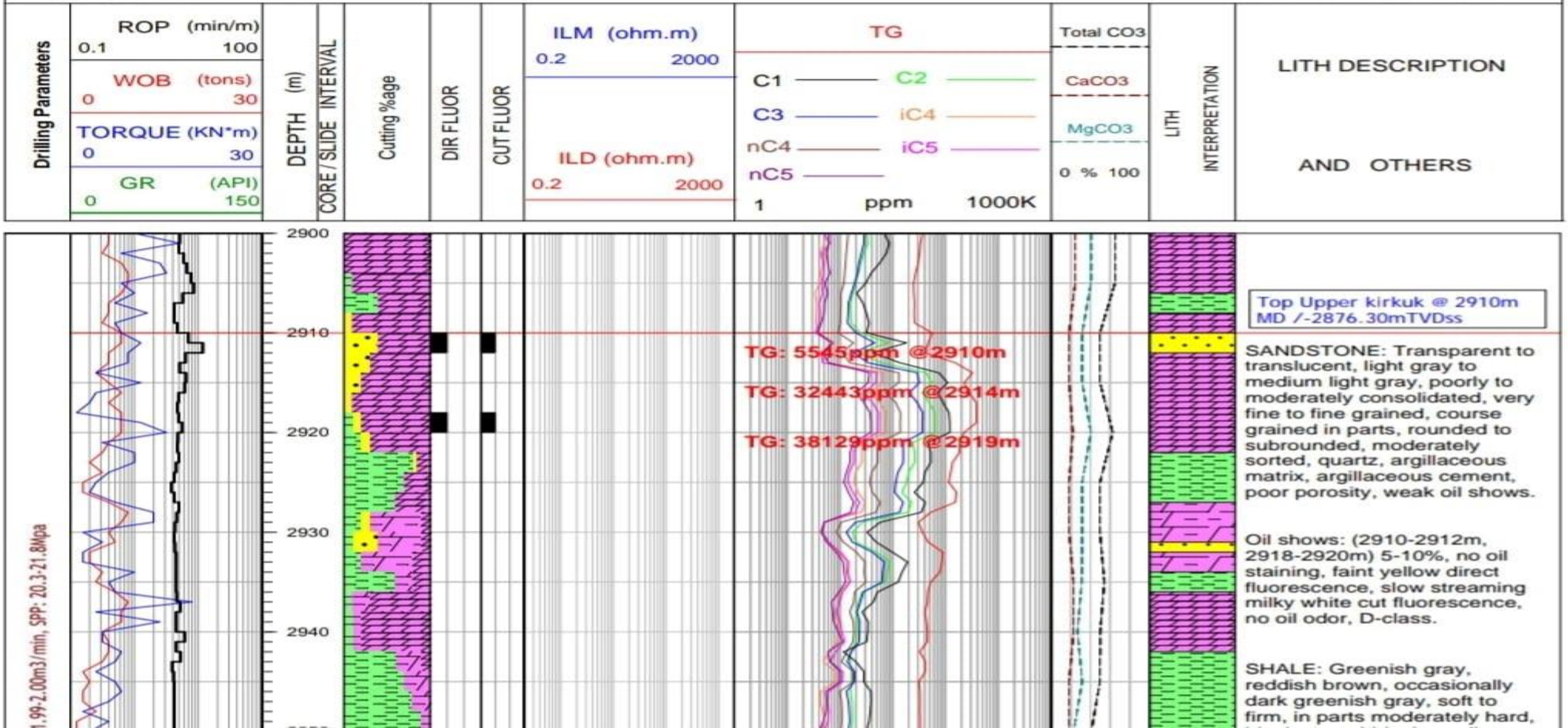
Mud Loss
Mud Gain
TD
Casing shoe
Chert
POOH/ RIH
Slide
Core
No Show
Weak Show
Fair Show
Good Show

LITHOLOGICAL LEGEND

Clay, Shale
Sandstone
Limestone
arg.Dolomite a
Siltstone
ar.Limestone a
ca.Shale ca
a,c Sandstone
Anhydrite
Dolomite
Chert
Salt

Logging Unit: DMLF 191

Contractor: BHDC



Measuring of Gas

When the drilling fluid returns to the surface. A trap is used to remove gas samples from the return line.

1. **gas associated with an oil show (C3, C4, and C5)**
2. **gas associated with an gas show (C1 and C2)**