



WELL LOGGING

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Well Logging

- ⦿ Known as **borehole logging**.
- ⦿ Making a detailed record (a *well log*) of the geologic formations penetrated by a borehole.



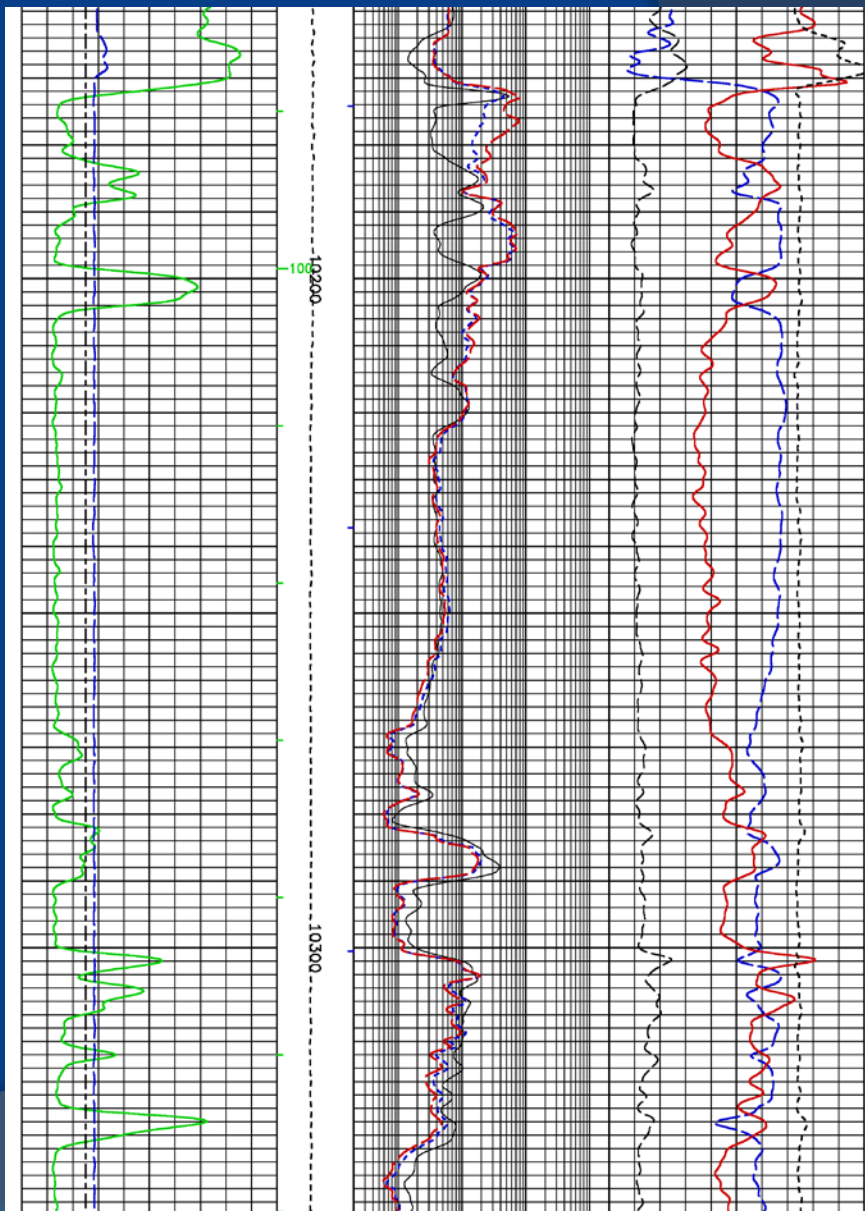
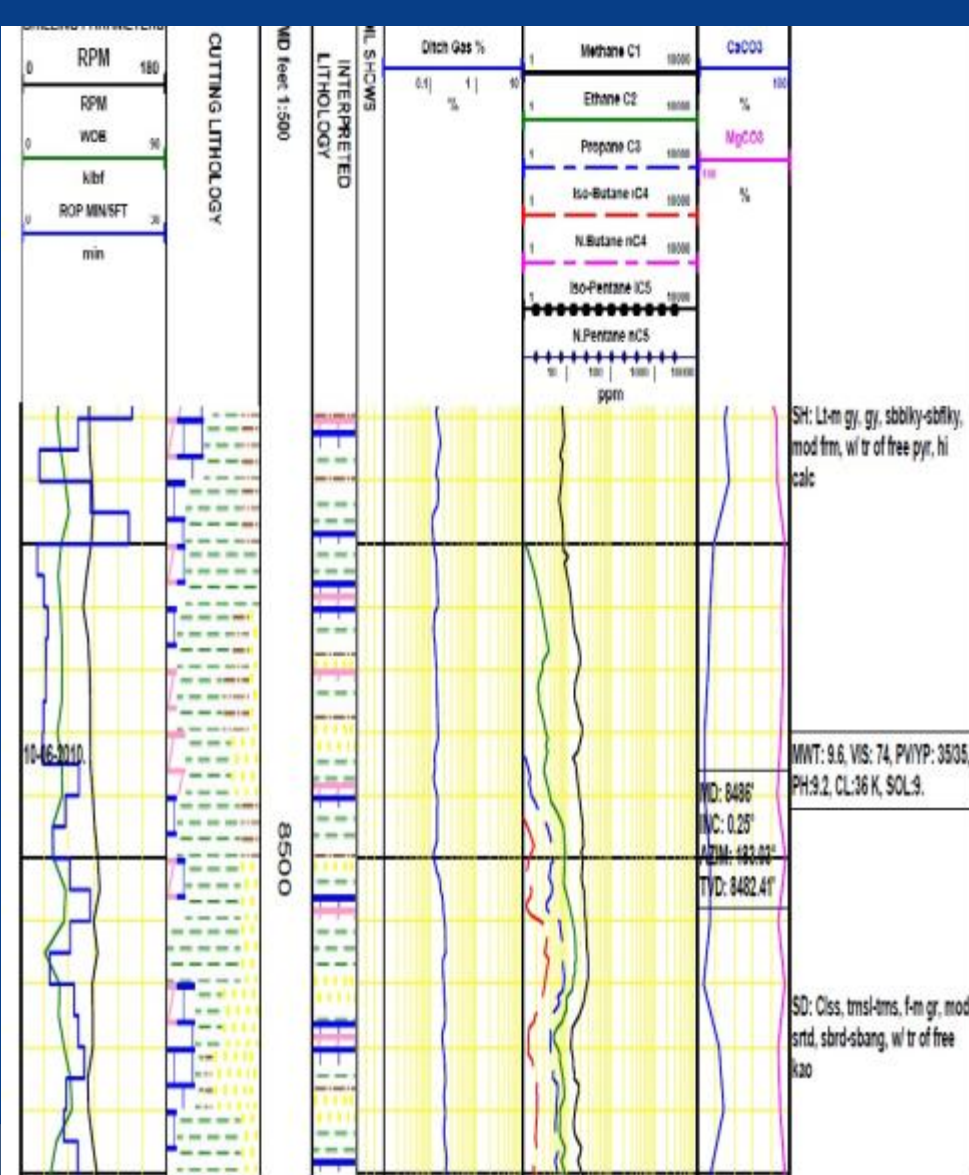
Well Logging

Points of comparison	Geological well logging	Geophysical well logging
Data out put	Mud log	Composite e- log
Logging time	Prepared during drilling	Recorded after drilling
Type of data	<ul style="list-style-type: none">• Lithology percentage• Gas percentage & its analysis• Rock description• Drilling parameters• Mud data	<ul style="list-style-type: none">• It represents the only continuous record of real lithology.• All the runs from the well must be plotted to give one composite plot

Well Logging



Well Logging



Mud logging unit

- ◎ The mud logging unit is considered as the **information centre** of the rig site as the unit participates in the **monitoring** of each and every **rig operation**. It serves both **exploration & drilling**.

MUD LOGGING UNIT



MUD LOGGING UNIT

1. Collection, description & examination of the **rock cuttings** & then **packing** it according to the exploration company requirements.
2. **Detection & Analysis of the Hydrocarbon gas** .
3. Detection of the **Hydrogen sulphide (H₂S)** gas while drilling which is very dangerous if it is not detected in the very early stage.
4. Monitoring the **drill fluid volume** second by second and to immediately inform the personnel in charge about any change in that volume (**Loss/Gain**).
5. Generation of **mud logs and graphs** during the drilling of the well.
6. Monitoring of the **drilling parameters** such as : WOB, RPM, TRQ...etc.
7. Confirming with the **driller** about any **drilling breaks**
8. **Trip monitoring** & preparing the **trip sheet**. The trip sheet includes the calculated hole fill-up or **string displacement** along with remarks on string **overpull, tight spots and running speed**.
9. Detection and evaluation of the **formation pressure**.

Mud logging unit team

• SAMPLE CATCHER.

- Collect and prepare sample for mudlogging geologist

• MUDLOGGING GEOLOGIST.

- Cutting & Core Description, Hydrocarbon Show.

• Data Engineer, PRESSURE Engineer.

- Record, monitor & analyse the drilling parameters such as ROP, RPM, WOB, Torque,
- Mud data: mud tank level (mud loss & gain)
- Mud weight in/out, temperature in/out
- Mud pump data : capacity, efficiency, volume in



Mud logging unit components



The Gas System

Gas
Trap



Gas

Chromatograph
(PPM)

Methan
 CH_4

Ethan
 C_2H_6

Propan
 C_3H_8

Butan
 C_4H_{10}

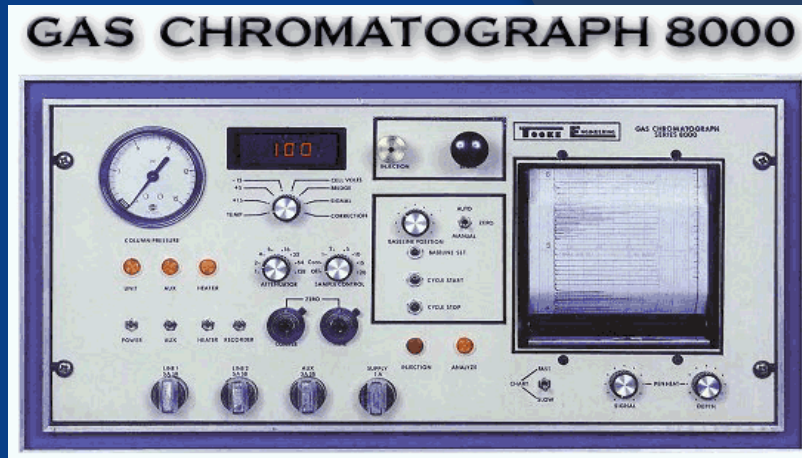
Pentan
 C_5H_{12}

The Quantitative gas measurement Q.G.M

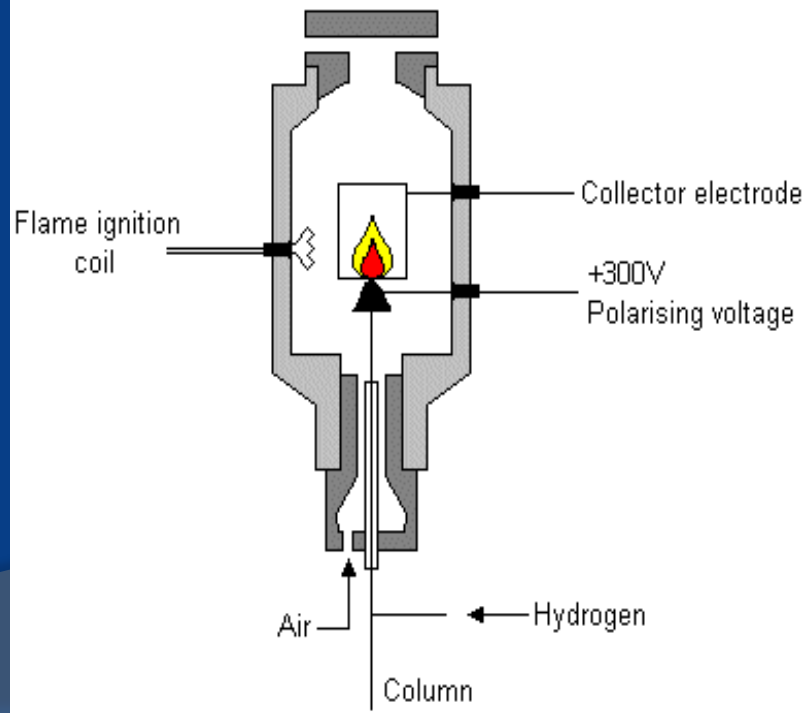


Flame Ionization Detector

- The flame ionization detector (FID) is the most **sensitive** gas **chromatographic detector** for hydrocarbons.
- When many **organic compounds** are **burned** in a **hydrogen flame**, charged particles or **ions** are given off.
- The released **ions** are forced to **travel** as a small current into an **amplifier** called the **electrometer**.
- The current flow is extremely small on the order of 10^{-9} to 10^{-12} amperes and the **electrometer produces** a **voltage** proportional to this current. In this way the voltage generated is **proportional** to the amount of **hydrocarbons** present in the sample.



The Flame Ionisation Detector



Types of Recorded Gases

● Cuttings gas (formation gas).

It is the gas liberated from the **drilled cuttings** enters the wellbore mud.

Factors affecting the size of the gas show:

- ❖ Rate of penetration (ROP)
- ❖ Differential pressure & Porosity
- ❖ Hole size.
- ❖ Depth.

● Background Gas.

Can originate from a **previously drilled section**, which bleeds a small amount of gas into the mud.

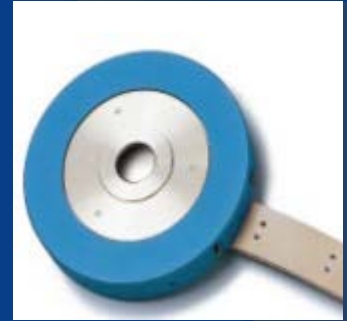
● Connection Gas.

A brief influx of gas that is introduced into the drilling fluid when a **pipe connection** is made. Before making a connection, the driller **stops** the **mud pumps**, thereby allowing gas to **enter** the **wellbore** at depth.

● Trip Gas

Gas entrained in the drilling fluid during a pipe trip, which typically results in a significant increase in gas that is circulated to surface.

Sensors



PUMP STROCK SEN.
FLOW OUT SEN
TORQUE SEN.
PIT VOLUME SEN.
DEPTH SENSOR
ROTARY SPEED SEN
HOOK LOAD SEN



Sensors (computers).



DEPTH SENSOR

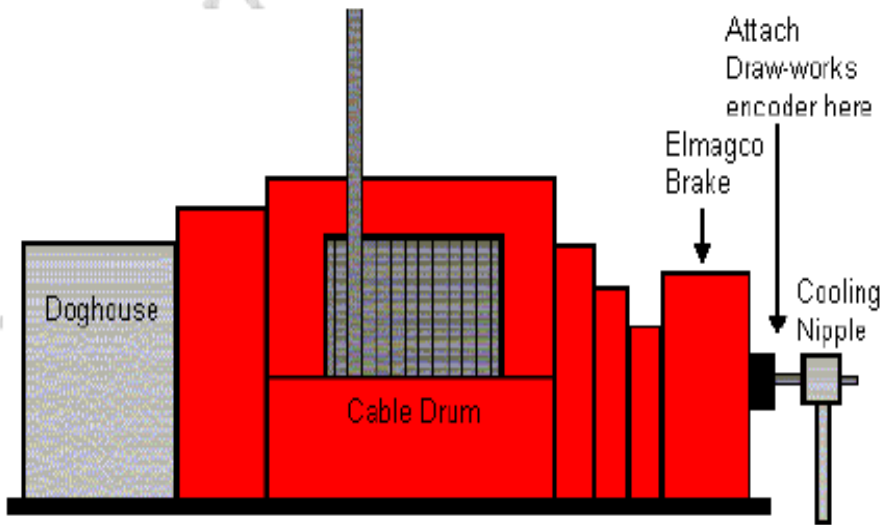
HOOK LOAD SEN



T SEN



PUMP STROCK SEN



RO



PIT VOLUME SEN

Sensors (computers).



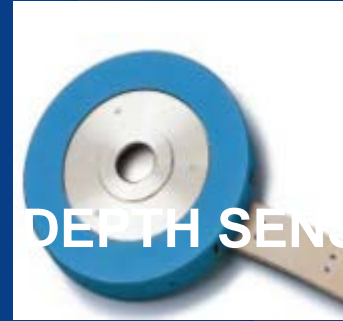
TORQUE SEN



ROTARY SPEED SEN



PVT VOLUME SEN



DEPTH SENSOR



HOOK LOAD SEN

FLOW OUT SEN



PUMP STROCK SEN



Sensors (computers).



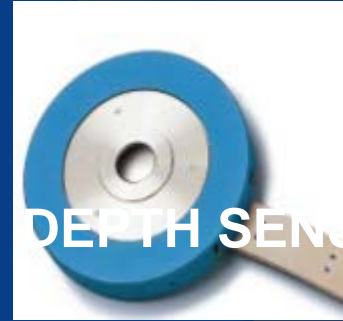
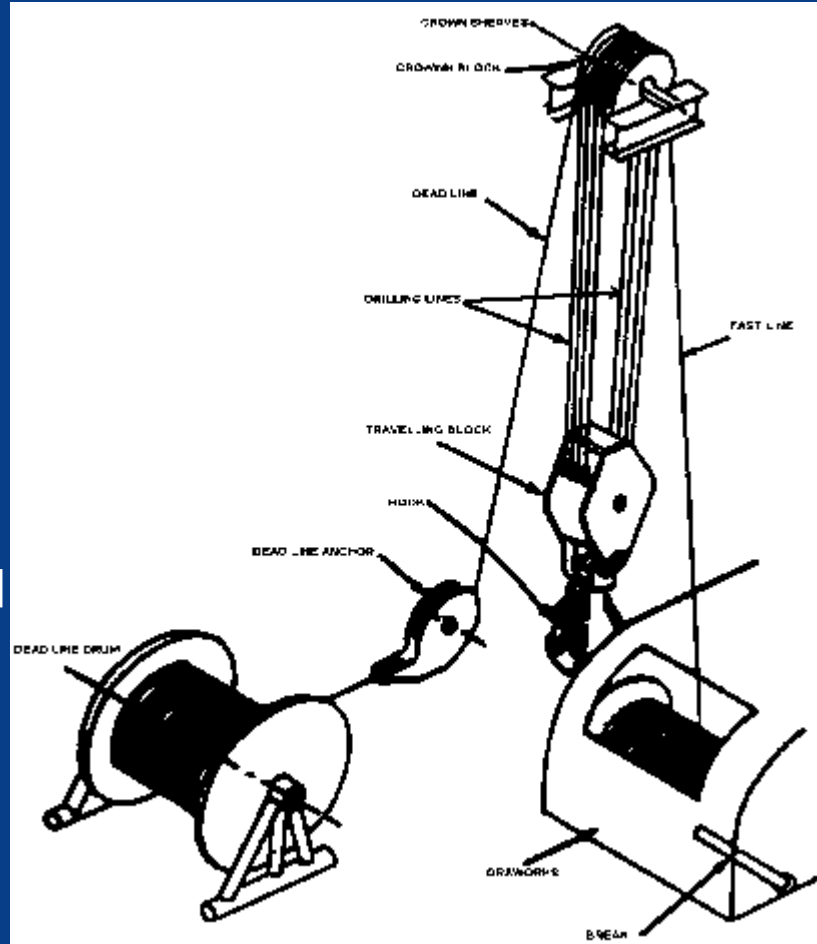
TORQUE SEN



ROTARY SPEED SEN



pH VOLUME SEN



DEPTH SENSOR

HOOK LOAD SEN



FLOW OUT SEN



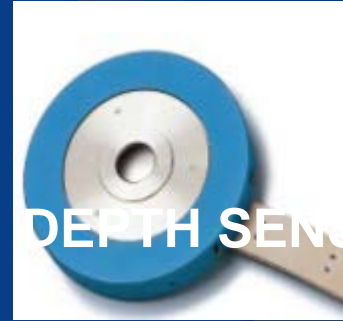
PUMP STROCK SEN



Sensors (computers).



TORQUE SEN



DEPTH SENSOR



ROTARY SPEED SEN



HOOK LOAD SEN



FLOW OUT SEN



PUMP STROCK SEN



PVT VOLUME SEN



Sensors (computers).



TORQUE SEN

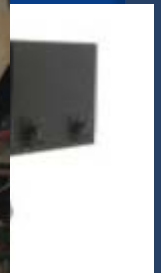


DEPTH SENSOR

HOOK LOAD SEN

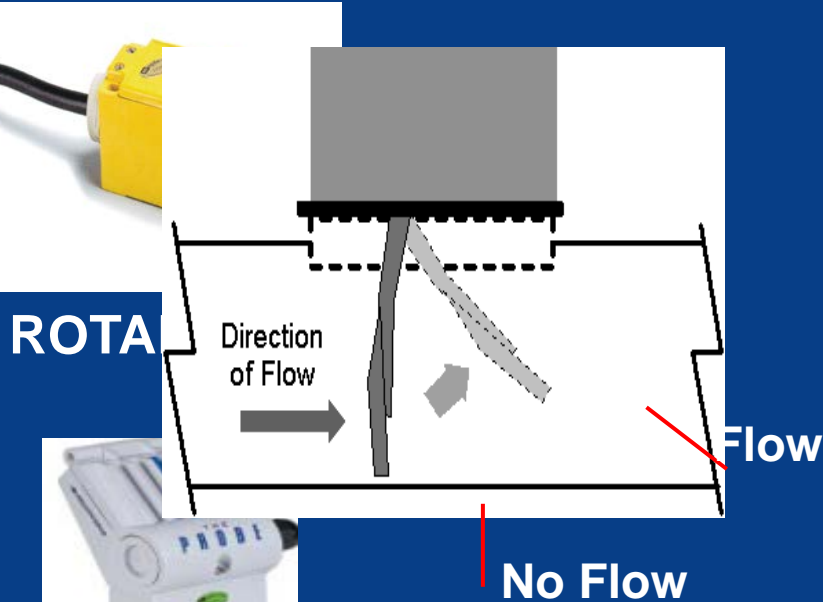


OUT SEN



OCK SEN

ROTA



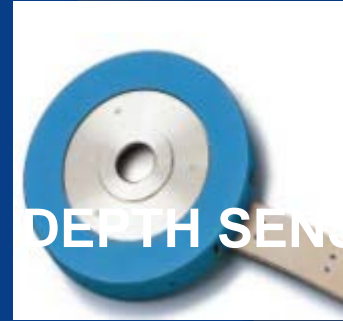
PIT VOLUME SEN



Sensors (computers).



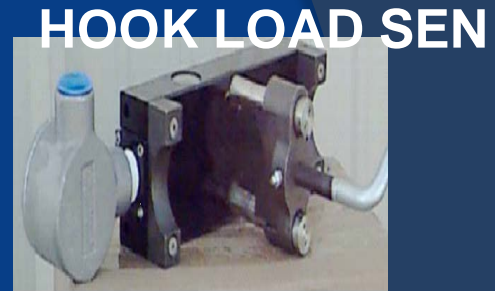
TORQUE SEN



DEPTH SENSOR



ROTARY SPEED



HOOK LOAD SEN

FLOW OUT SEN



PUMP STROCK SEN

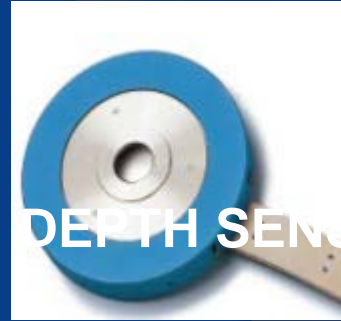


PVT VOLUME SEN

Sensors (computers).

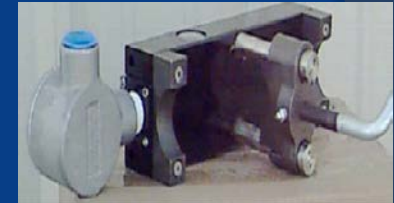


TORQUE



DEPTH SENSOR

HOOK LOAD SEN



FLOW OUT SEN



PUMP STROCK SEN



PVT VOLUME SEN



Microscope



Samples

- **Types** of samples:

1. Wet samples.
2. Dry samples.
3. Geochemical Samples.
4. Coring.

- Several **reasons** for sample collection and shipping are:

1. Paleontological/ Palynological analysis.
2. Geochemical analysis.
3. Oil company partners.
4. Governmental requirements.
5. Future reference/library samples.

- The sampling **interval** is usually set by the client, and is normally:

every **10 feet** (3 meters) OR
every **30 feet** (10 meters)

Wet samples

- Collected at the shale shaker.
- Normally the drilling **fluid** is not **rinsed off**.
- This is bulk sample material used mainly for **paleontology**.



Dry samples

- Obtained from the **washed samples** collected from the **80-mesh sieve**.
- A heat source is used for **drying** purposes.
- **Do not** oven dry **oil-based mud** samples
- Do **not over-dry** samples, because they will burn (the burning can be mistaken for oil staining)
- **Clay samples** should not be oven dried - only **air dried**



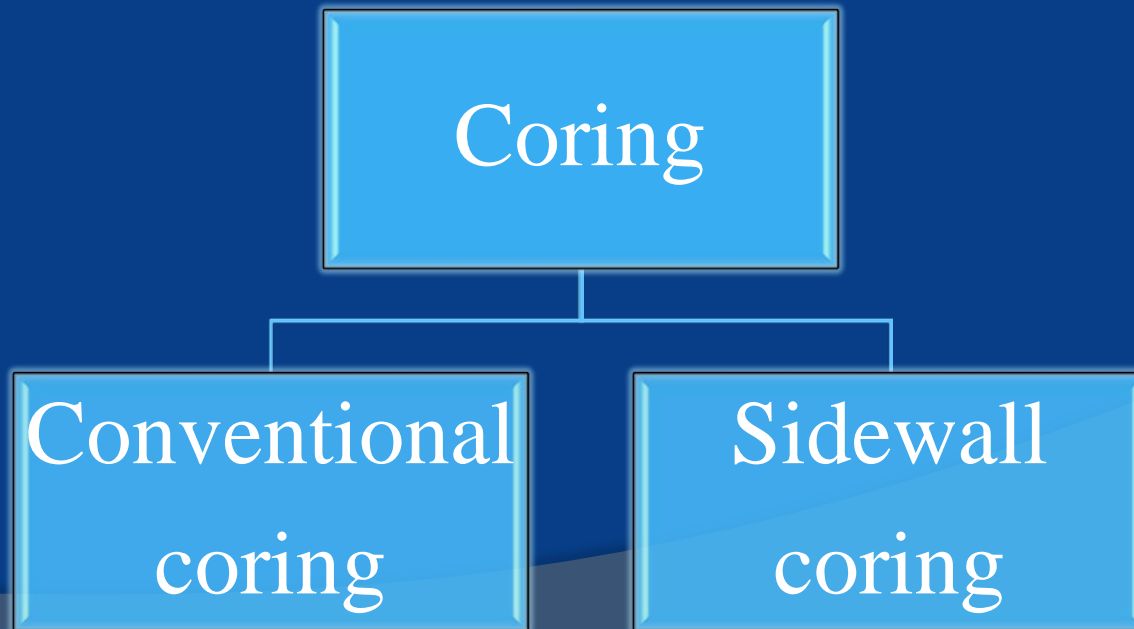
Geochemical Sampling

- ⦿ Taken over **larger intervals** and are composites of **unwashed wet** samples.
- ⦿ When collected in a **metal or plastic** container, **fresh water** and the **bactericide** are added, leaving approximately **3 cm** of air-space for **gases to collect**.
- ⦿ Once **sealed**, they are best stored **upside down** in their shipping containers. **Fast transport** to town is indicated
- ⦿ The **geochemist** in town will first punch a **small hole** in the cans to take the **headspace gas** for **chromatographic analysis**.
- ⦿ The **cutting** material is used to extract **organic compounds** for **chromatography** and **kerogen determination**.



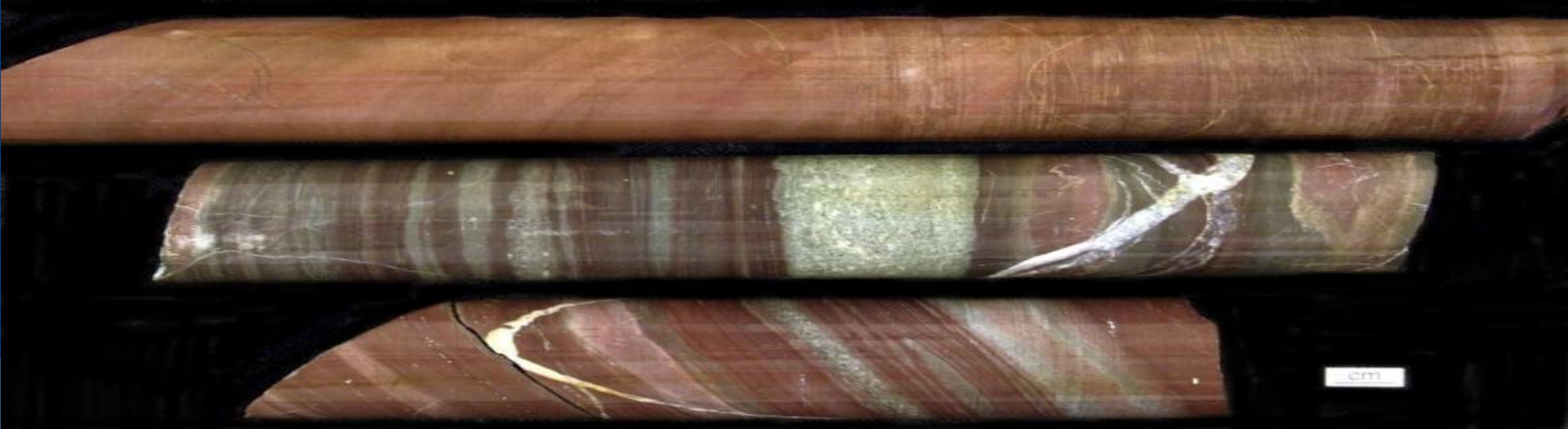
Coring

- ⦿ A core sample is a piece of rock that is **carved**, using a piece of **equipment** that works a lot like an apple-corer.
- ⦿ **Primarily** a core allows **quantitative** measurements of the following:
 - **Porosity** - The volume of voids within a unit volume of rock.
 - **Permeability** - The quality of the connections between the voids.
 - **Saturation** - The composition of the fluids filling the voids.
- ⦿ **Secondary** importance is the additional information relating to **formation boundaries**, **sedimentary structures**, undisturbed **paleontological data**, and uncontaminated **geochemical** sampling.



Conventional coring

- An assembly called a "**core barrel**" is made up on the drill string with a special type of bits called "**Core Head**" and run to the **bottom** of the hole. As the **core barrel** is **rotated**, it cuts a **cylindrical core** a few **inches** in diameter that is received in a tube above the core cutting bit.



Macroscopic Examination of Cores

1. The **lithology, thickness & dip** of major lithologic units
2. The **size and dip** of **bedding, sedimentary** and **diagenetic structures**
3. Type, amount and distribution of **secondary porosity**
4. Surface condition of natural **fracture surfaces**
5. Any **hydrocarbon staining** or odor
6. An estimation of **permeability**
 - a. **Excellent:** The core will be poorly consolidated and may fall apart during recovery
 - b. **Very Good:** Fluid will be bubbling from the core.
 - c. **Good:** It will be impossible to wipe the core dry. Any fluid wiped off will be replaced from within.
 - d. **Fair:** The core can be wiped dry, but after a period of time it will become wet again.
 - e. **Tight:** The drilling fluid on the surface will dry in air without wiping.

Sidewall Coring

A core taken from the side of the borehole by a wireline tool.

Advantages:

1. **Lithology and mineralogy** of sections are readily obtained, and
2. **Oil shows** from cuttings analysis can be **confirmed**.

Disadvantages:

1. Detonation often **induces fractures** in the sample and strata,
2. The **small** volume of rock is **not** highly **representative** of the **strata**, unless **multiple shots** are taken, and
3. Sidewall cores are **easily broken** when handled after collection

