Contents

- What is ditch/drilling cuttings?
- Why cutting analysis?
- Lag Time Calculation
- Contaminations
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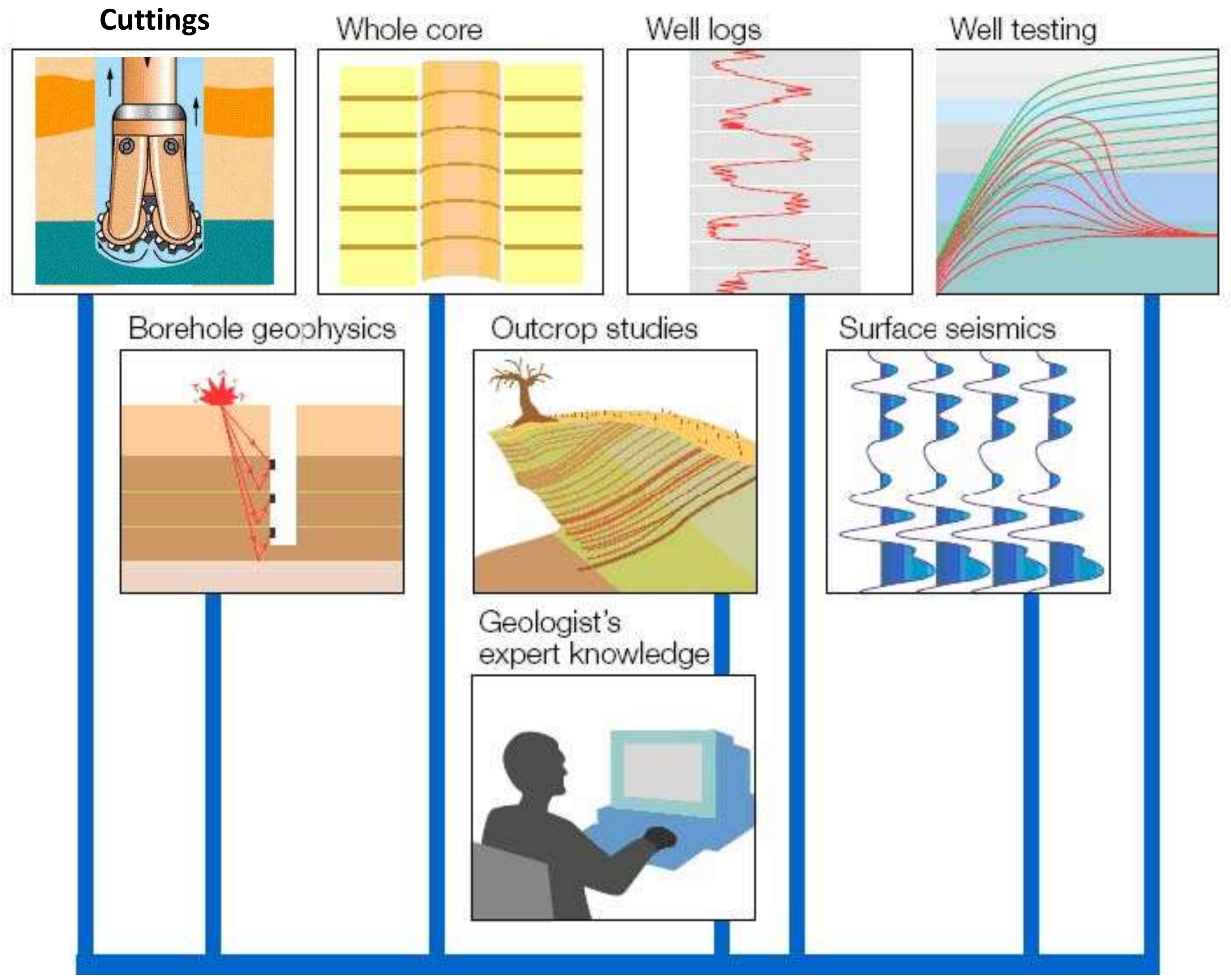
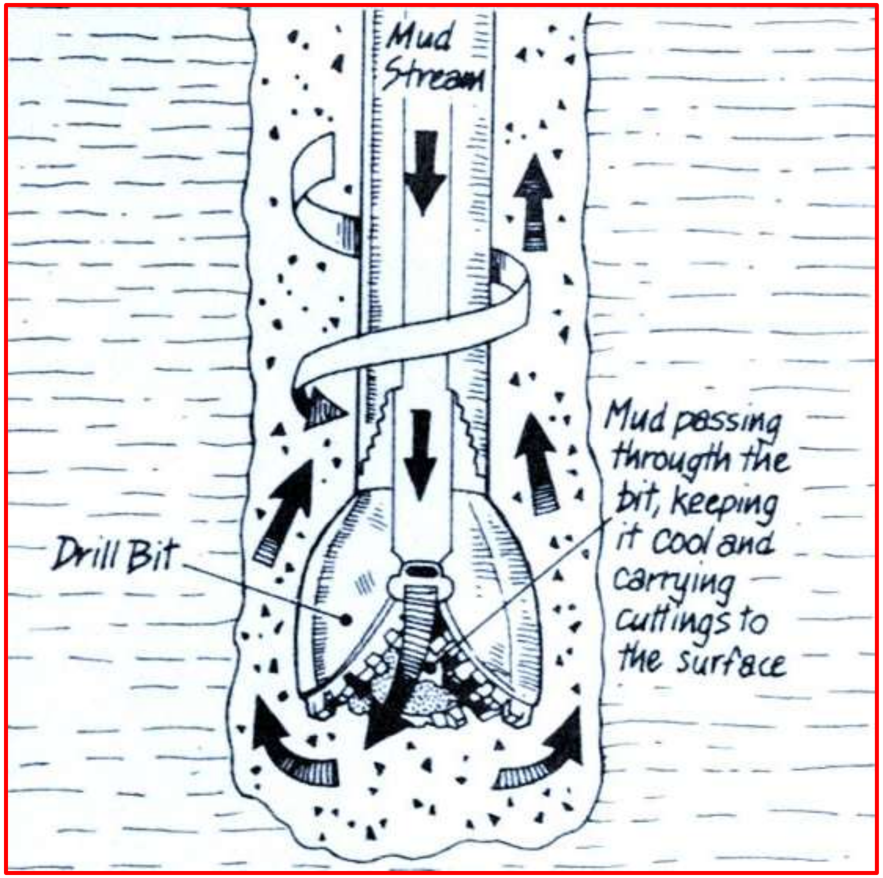
- Cuttings Petrography

Data Source


Cuttings
Whole core
Well logs
Well testing
Borehole geophysics
Outcrop studies
Surface seismics
Geologist's
expert knowledge

Well cuttings

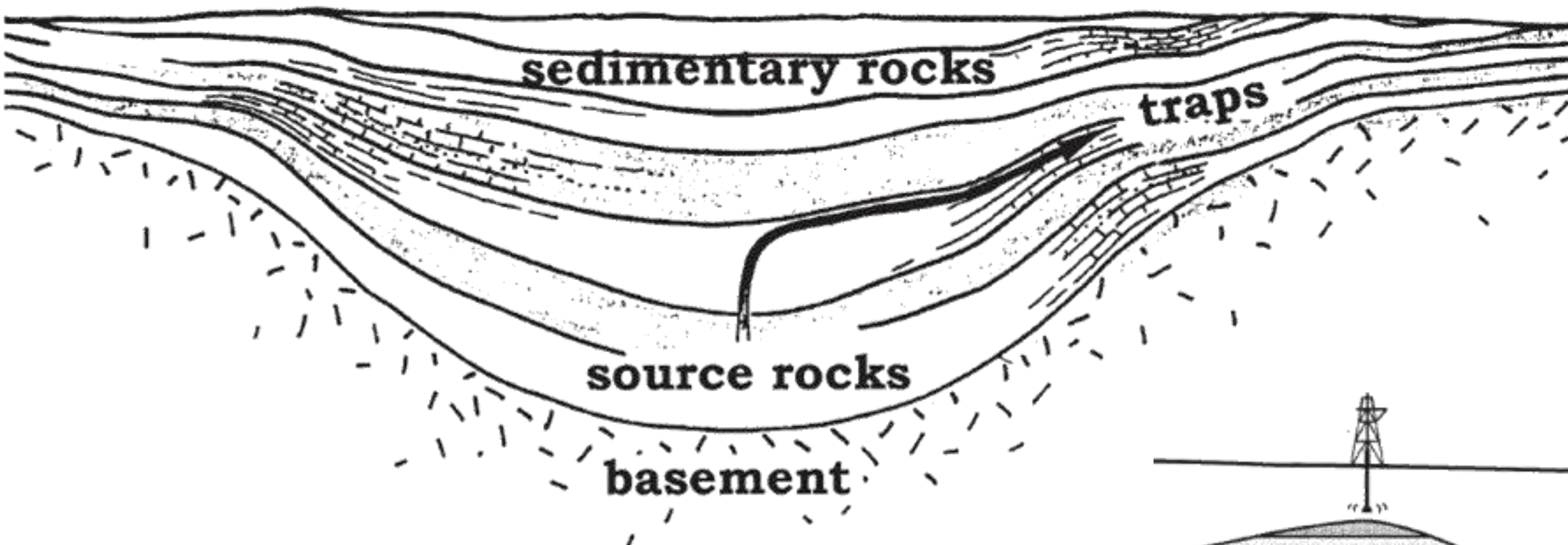
- *Cuttings* are the small pieces of rock that are chipped away by the bit while a well is being drilled.
- Well cuttings are sampled at regular interval usually **2 m** (wildcat wells) and **5 m** (production wells).
- Interval is short at reservoir is strike called ditch sample.

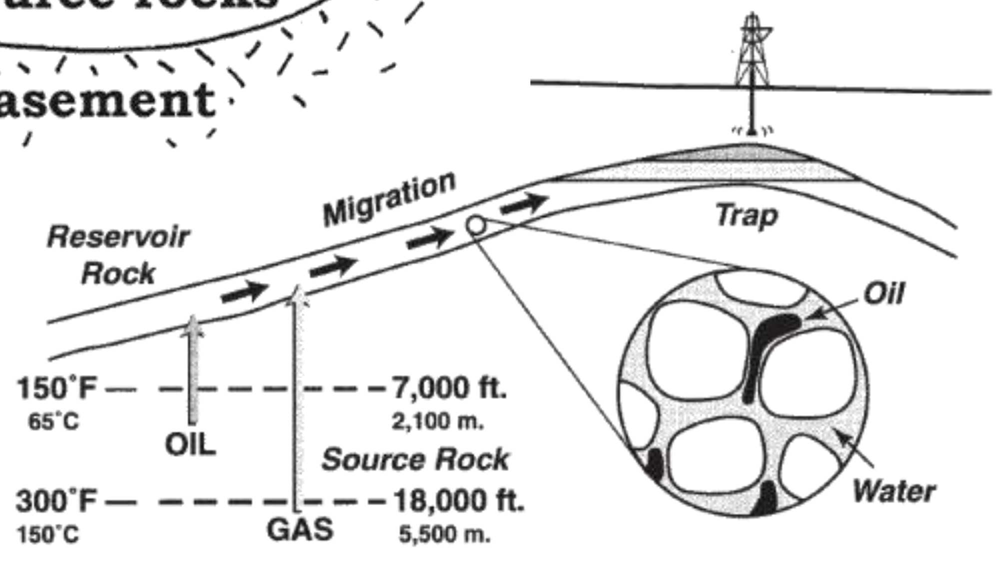


Why Cutting Analysis?

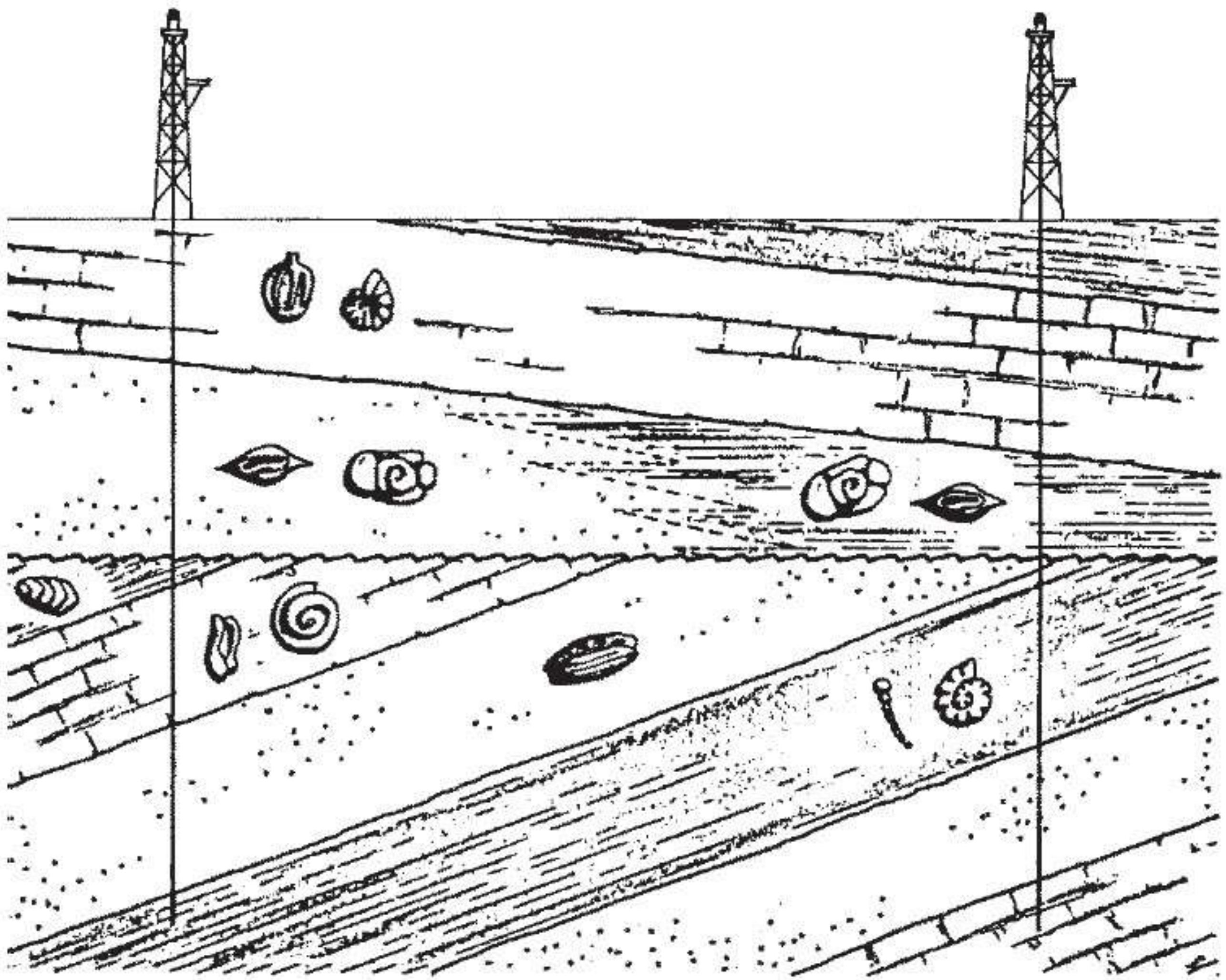
Stratigraphic Description	• Selection of the right drill bit • Configuration of the mud system • Fixing the exact casing depth • Final decision for a core run
Petrographic Characteristics	• Characterisation of a reservoir • Basic parameter of hydraulic systems
Petrographic & mineralogical Composition	• Input parameter for the log interpretation (EFA Log)
Cutting analysis in general	• Redundance and back up in case of trouble (e.g. loss of borehole measurements due to bad caliper, inclination of the hole, stuck pipe, coring)

Basin and sedimentary cover

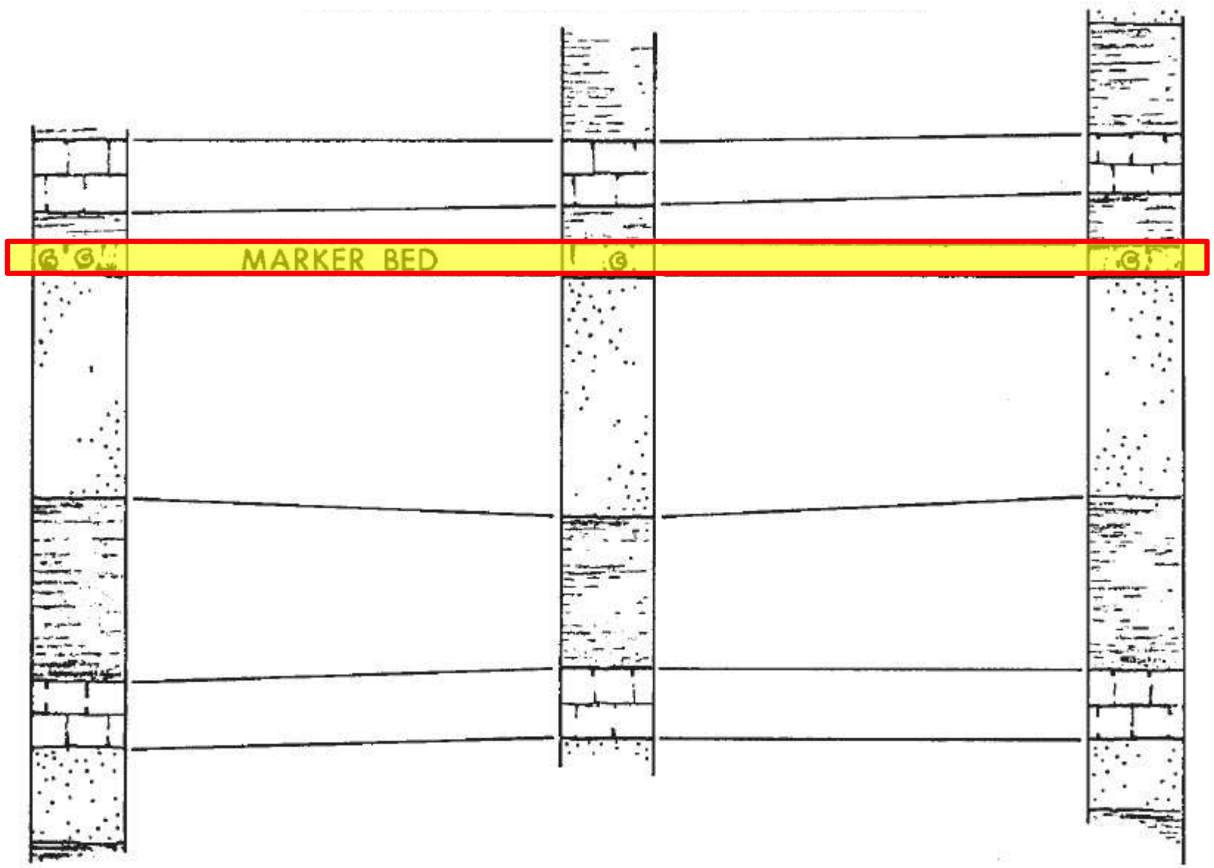




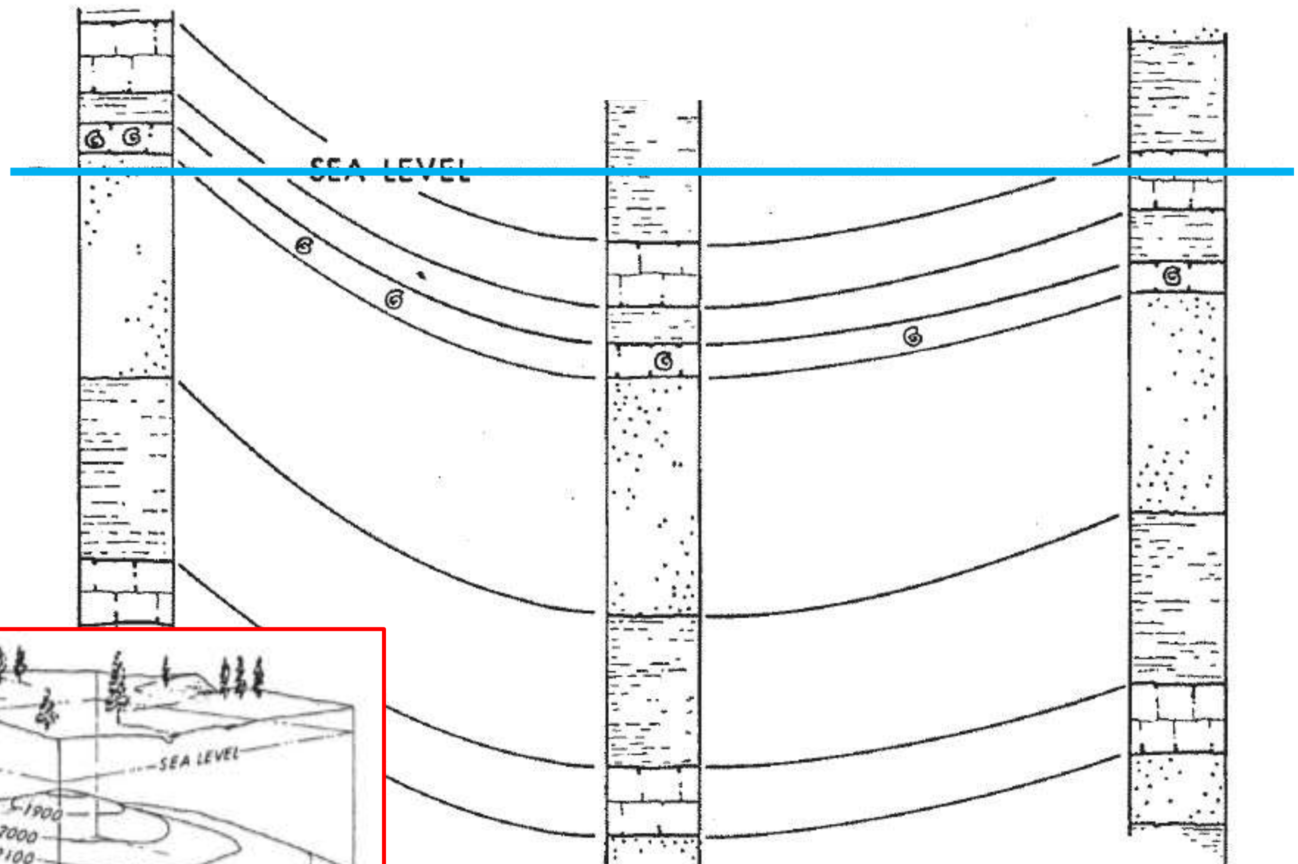
Stratigraphic Analysis

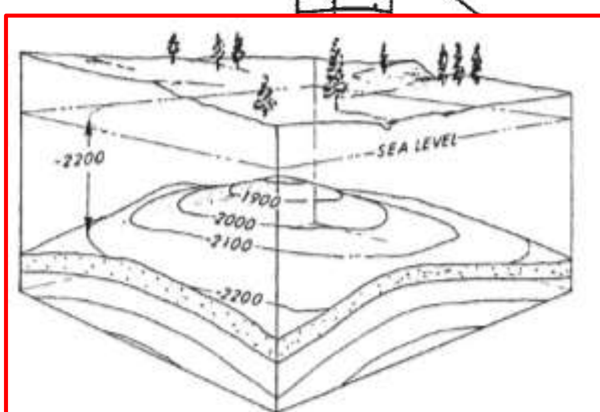


Stratigraphic Cross Section

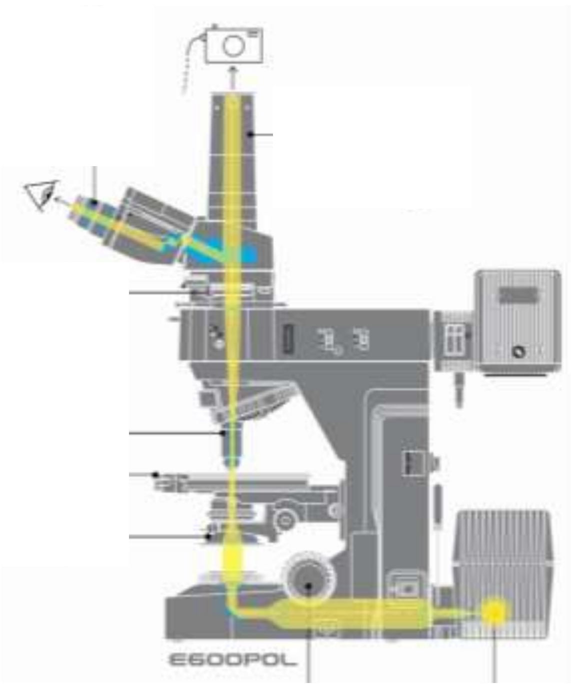


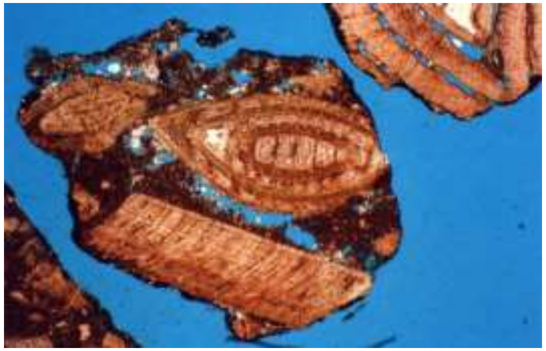
Structural Cross Section

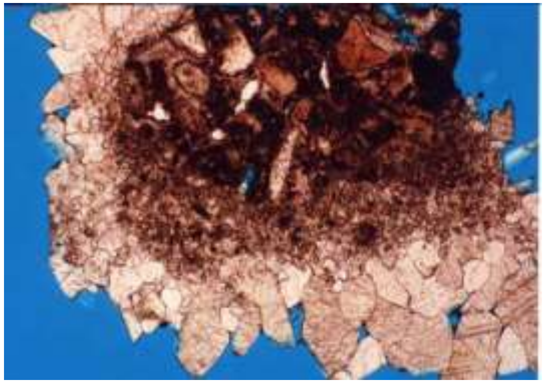


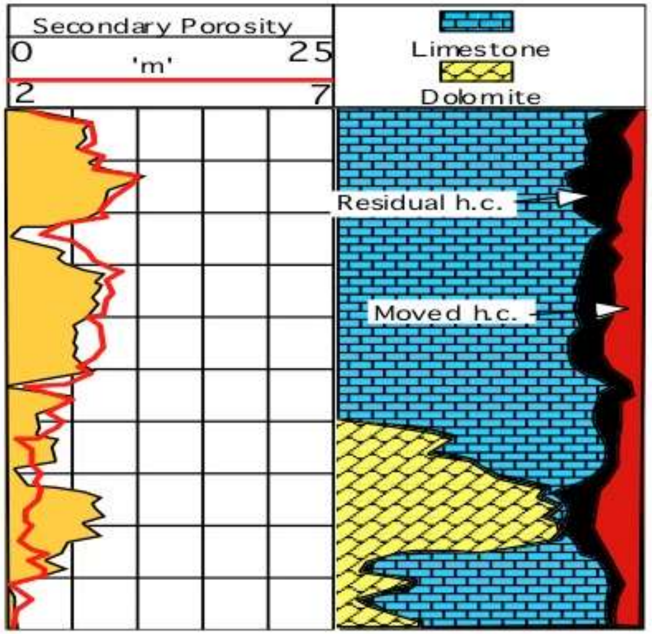


Petrography
(Mineralogy, Grain size, Fossil and Pore type)





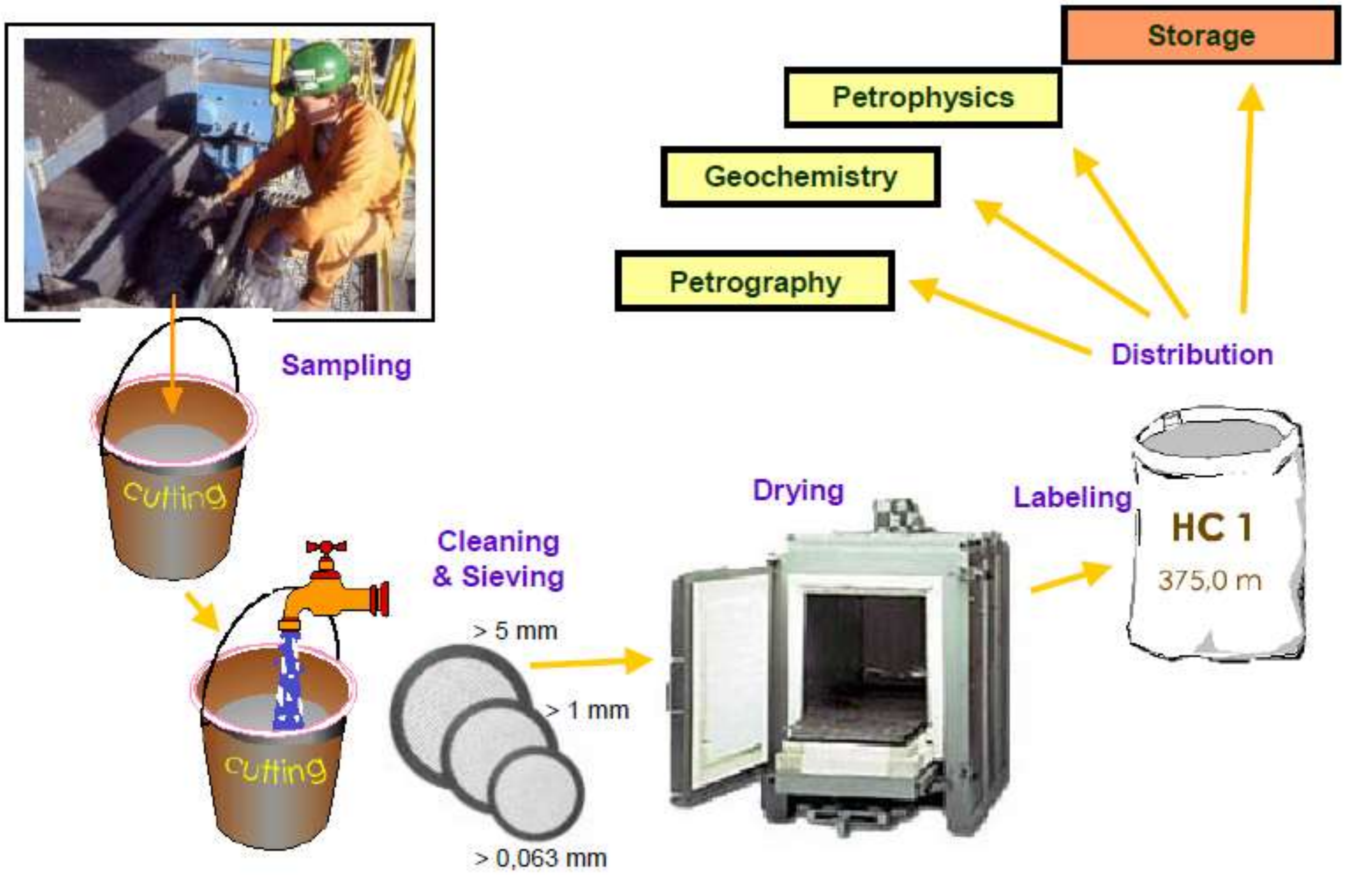




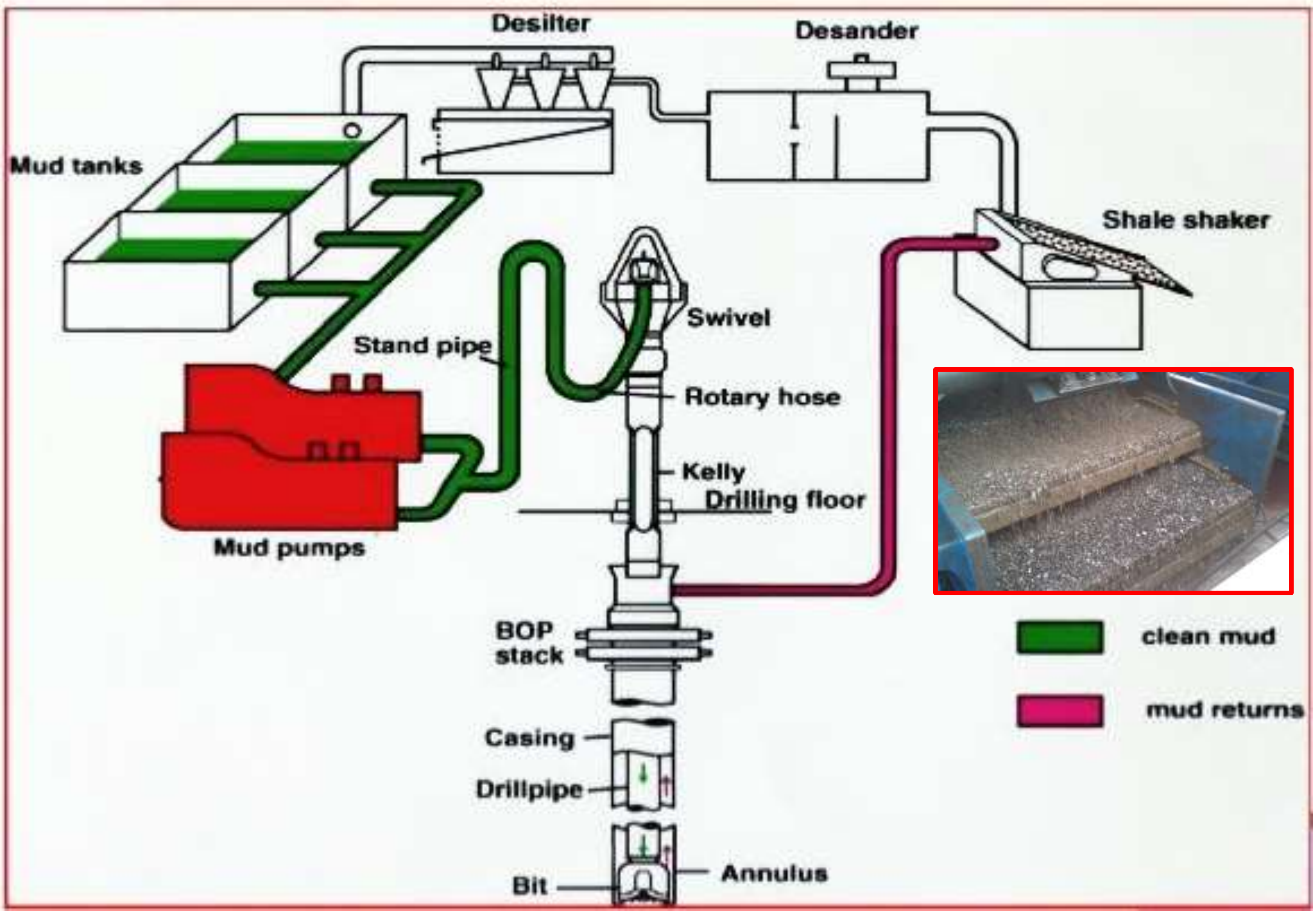
Advantage of Cutting Analysis

- Cheap and quick study
- First or only opportunity to look at the rock
- Immediate interpretation of Sed. Sequence
- Only small quantity of material required.
- Selection of fragments to be analyzed.
- Individual analysis of each fragments.
- Averaging of rock types over a certain interval
- Detailed information on rock composition, texture, fossil, …

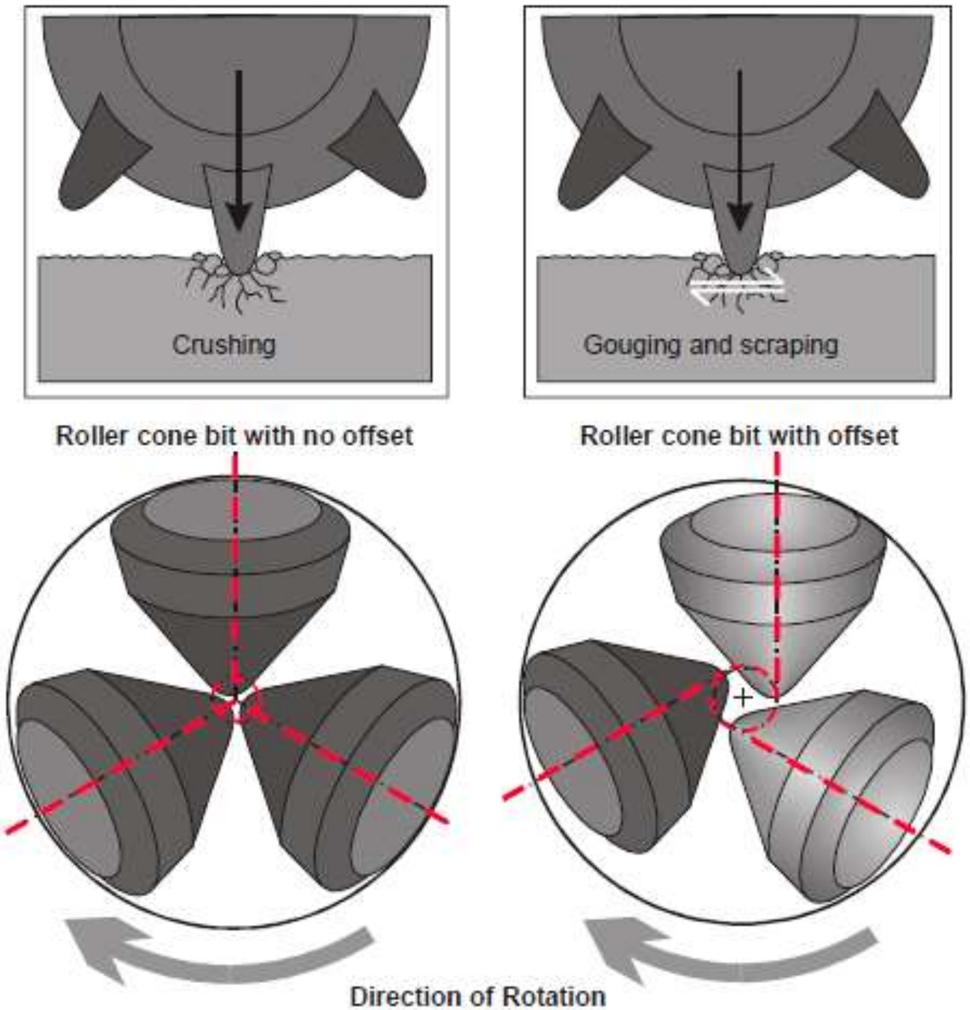
Catching and Preparation Of Cutting Samples



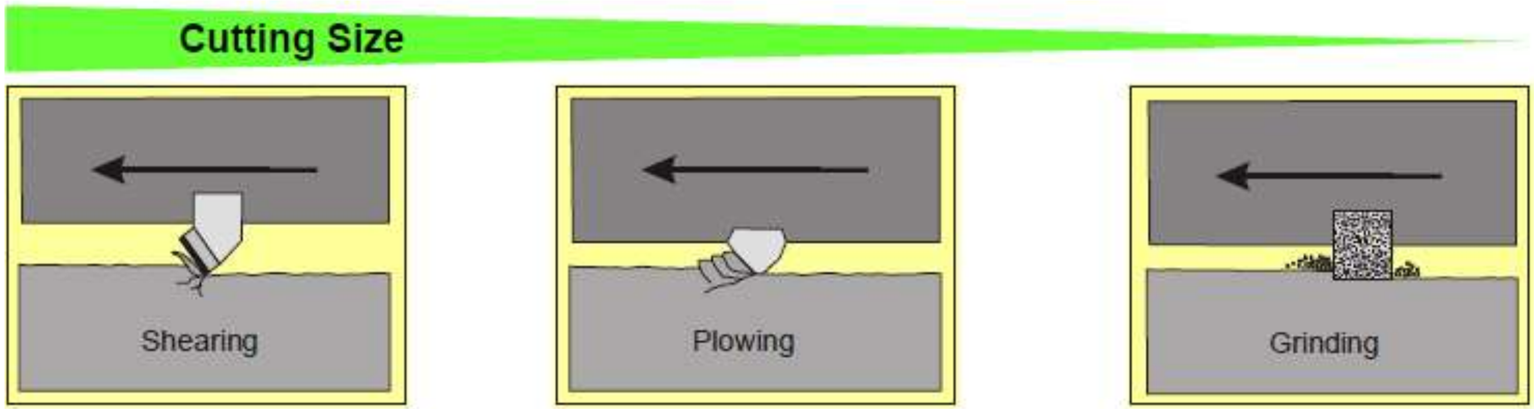
Mud Circulation System



How Bits Drill?



How Bits Drill?

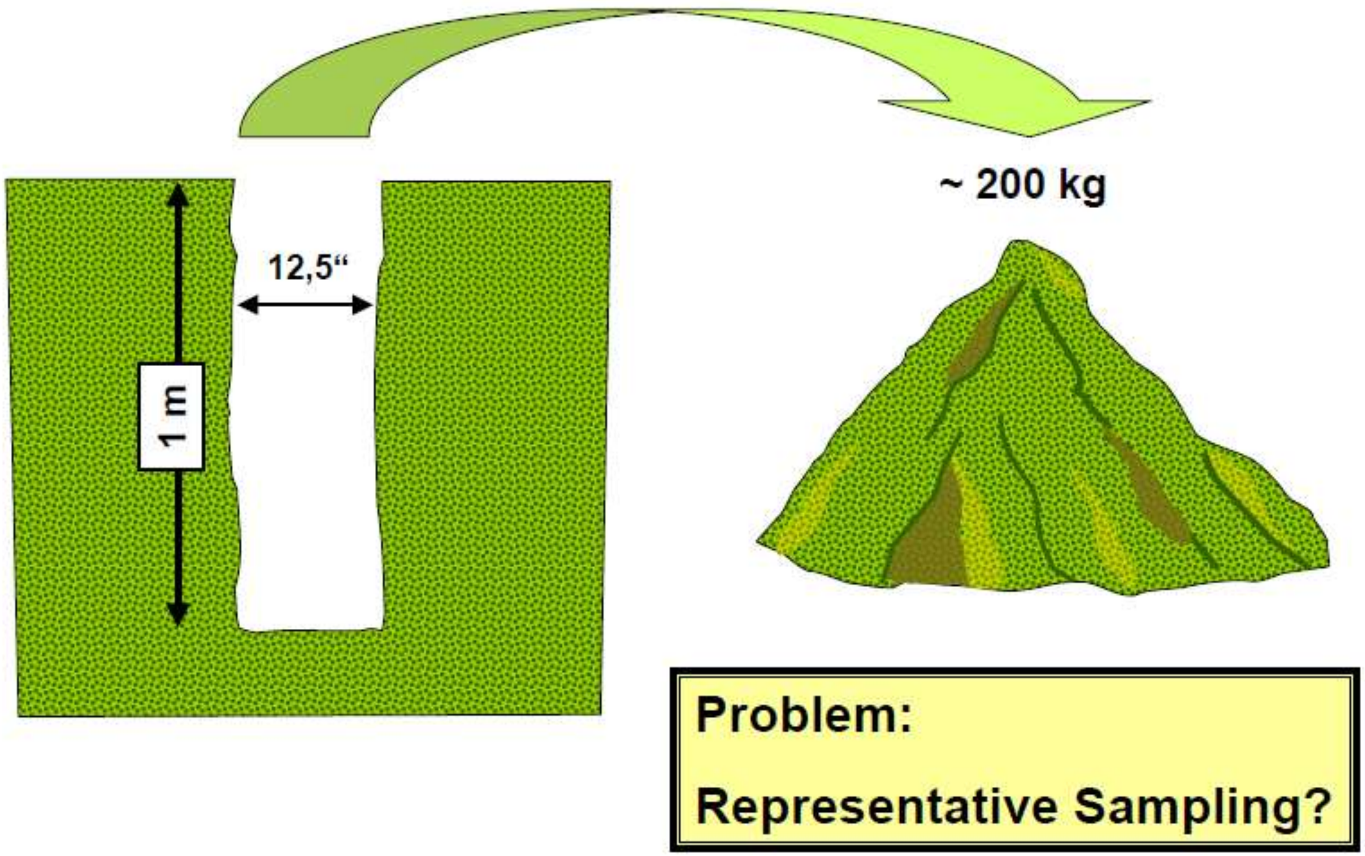


PDC bit

Natural diamond bit

Diamond-impregnated bit

How many Cuttings per Meter?



During a well drilling, the crushed cylinder of formation which is drilled to make the hole is released into the mud stream. Once released, the formation and any contained fluids, gas or oil are carried to the surface by the mud.

Cuttings Volume

Hole Size	Section Length	Section Volume	Time to Drill
24"	600m	175m ^{3}	2 days
17 $\frac{1}{2}$"	1400m	217m ^{3}	14 days
12 $\frac{1}{4}$"	1500m	76m ^{3}	30 days
8 $\frac{1}{2}$"	1000m	37m ^{3}	40 days
Total	4500m	505m ^{3}	90 days

±1200 Tonnes

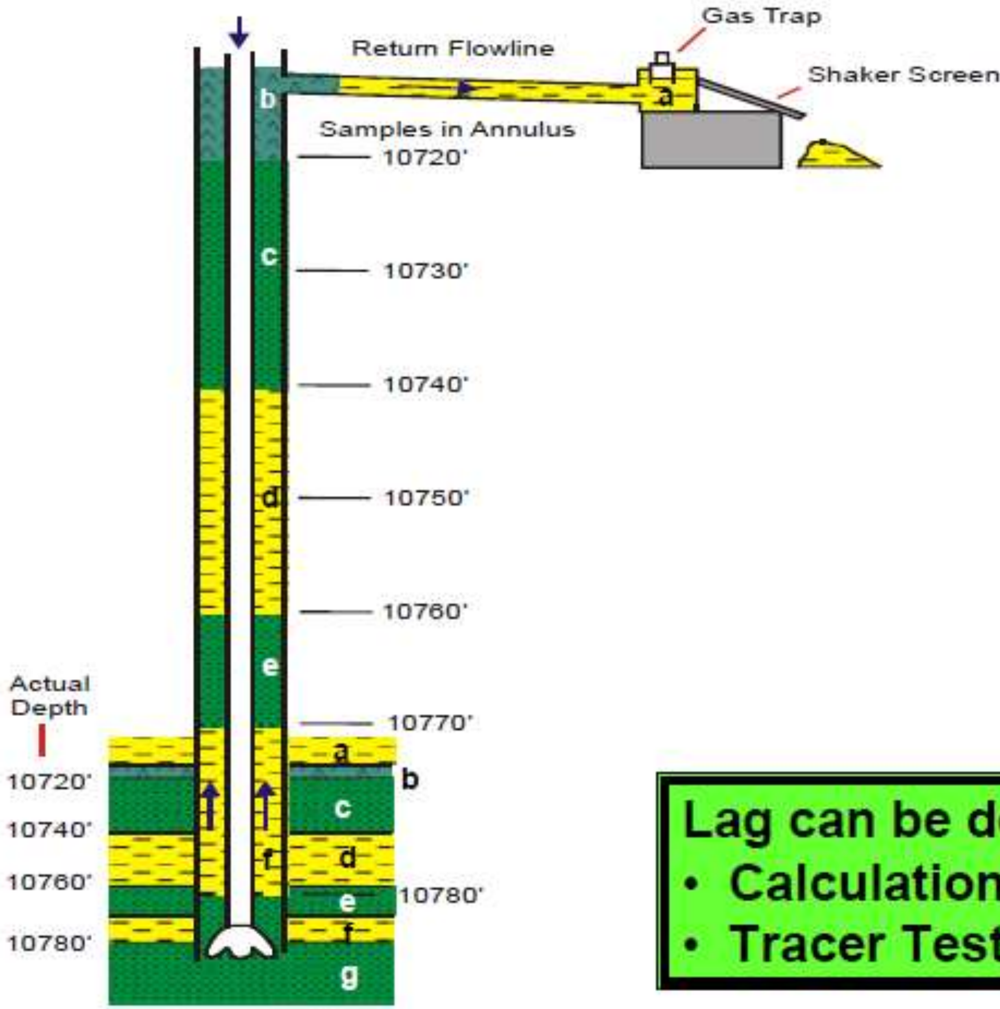
±165 Truck Loads

What is the Lag-Time?

„Lag-Time“ is the definite time interval, which is always required for pumping the samples from a particular depth to the surface where they become accessible.

The lag-time applies to all downhole information, the formation cuttings and the fluids (gas, oil and water) which they contain.

Sample lagging



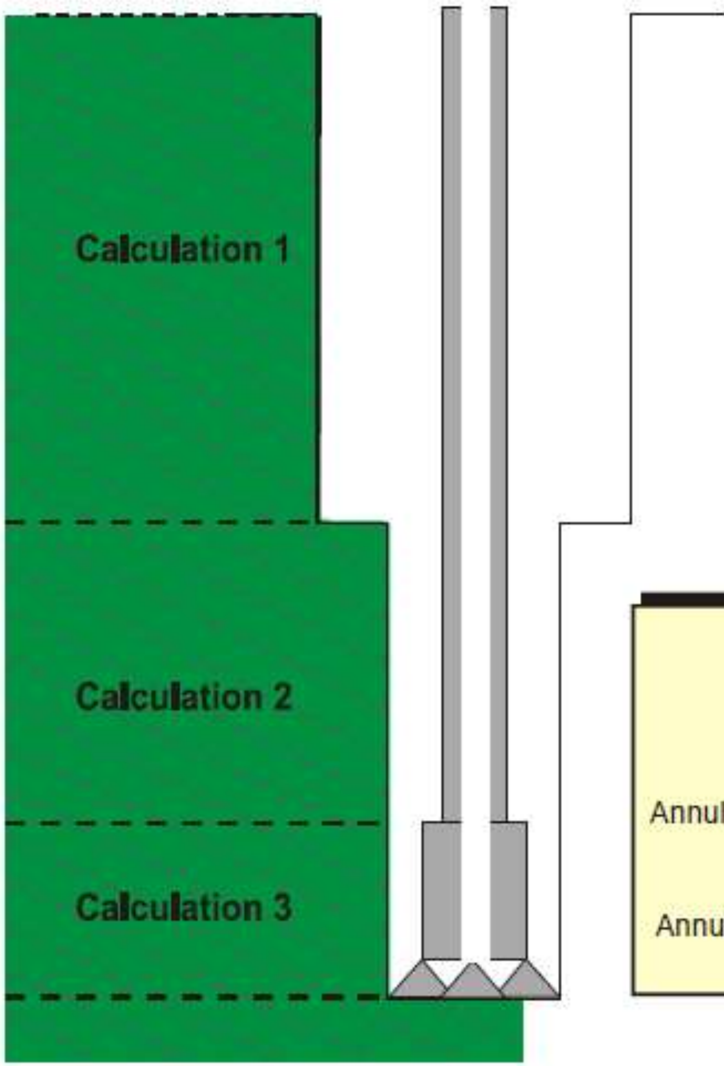
Lag time depends on:

- Depth
- Pump Rate
- Drill String Size
- Casing Diameter
- Hole Size
- Mud
- Mud Condition

Lag can be determined by:

- Calculation
- Tracer Tests

Lag Time Calculation



Problems:

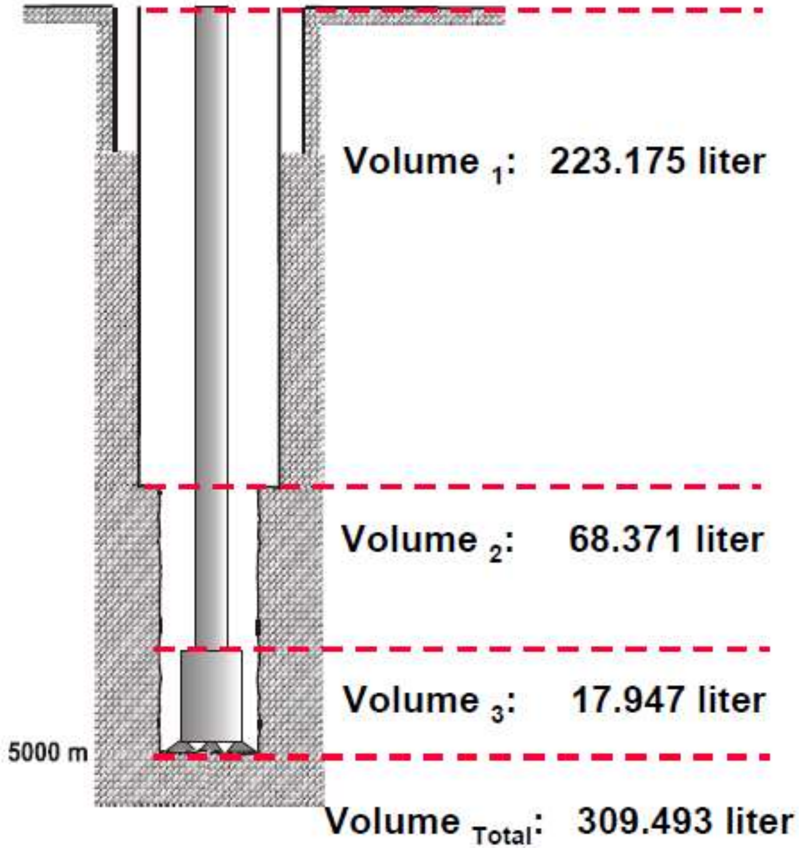
- Borehole breakouts
- Mud channels in the annulus

$$\text{Lag time} = \frac{\text{Depth}}{\text{Annular Velocity}}$$

$$\text{Annular Velocity} = \frac{\text{Pump Output}}{\text{Annular Volume}}$$

$$\text{Annular Volume} = \text{Hole Capacity} - \text{Pipe (Capacity + Displacement)}$$

Lag Time Calculation



Results:

12.380 strokes

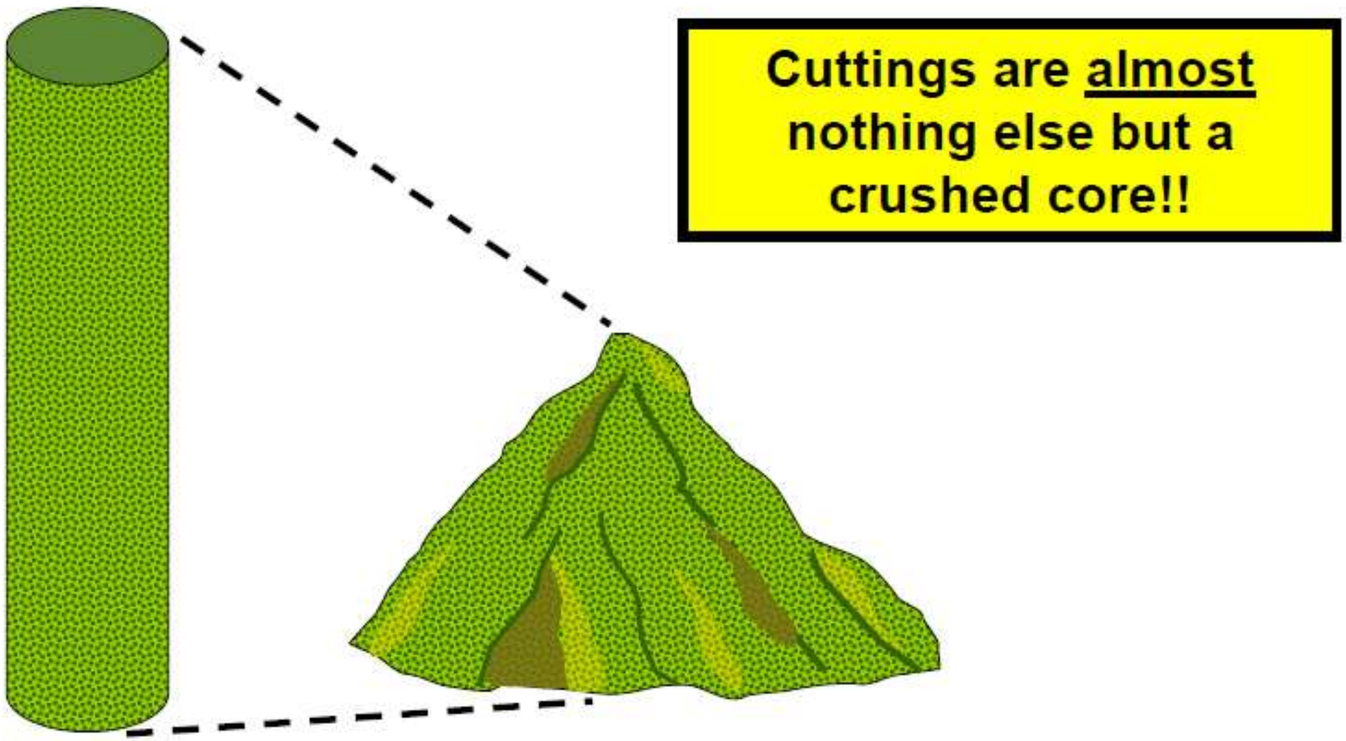
130,3 minutes

8,7 meters*

*) ROP = 4 m/h

Various materials (such as whole oats, rice, barley or lentils) may be used as tracers and picked up on the shaker screen for approximating the lag.

Cuttings and Core?!

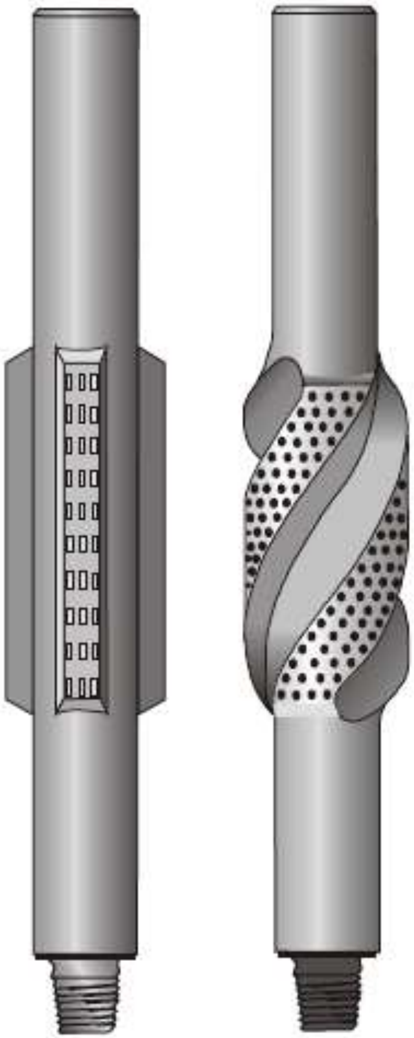


The drill bit and circulation perform a mechanical running average on the lithologies penetrated.

Contaminations

MINERALS	ORGANIC AND SYNTHETIC MATERIALS	METALS (SEE TABLE 2)
Drilling mud clays:	Drilling mud thinners and dispersants	Metal shavings from the drilling system
-Bentonite (montmori-llonite ± illite, mixed-layer clay and kaolinite)	-Lignite and lignosulfonate	-Steel, brass, etc.
-Attapulgite or sepiolite	Drilling mud lubricants	Drillable metal from downhole cementing assemblies
Drilling mud weighting Agents	-Silica or glass spheres	
	Lost-circulation materials	-Lead, iron and aluminum
-Barite -Hematite -Calcite -Galena -Ilmenite	-Nut Shells -Wood fiber -Cane fiber -Seed hulls -Paper -Lignite (coarse) -Cellophane -Processed formica and other plastics -Miscellaneous locally available material such as alfalfa cubes	Coloring agents Metals in thread compounds and other greases
Cement		
Cement additives		
-Silica flour -Perlite -Pozzolan -Diatomaceous earth -Bentonite -Hematite -Barite -Mica -Quartz sand -Gypsum	Cement Additives -gilsonite and coal Rubber and Plastic -Jackets on cement plugs	

Cavings



Cavings = Cuttings from previously drilled intervals

Recognizable:

large, splintery rock fragments,

often concave, convex in cross-section,

Identical with formations from higher sections,

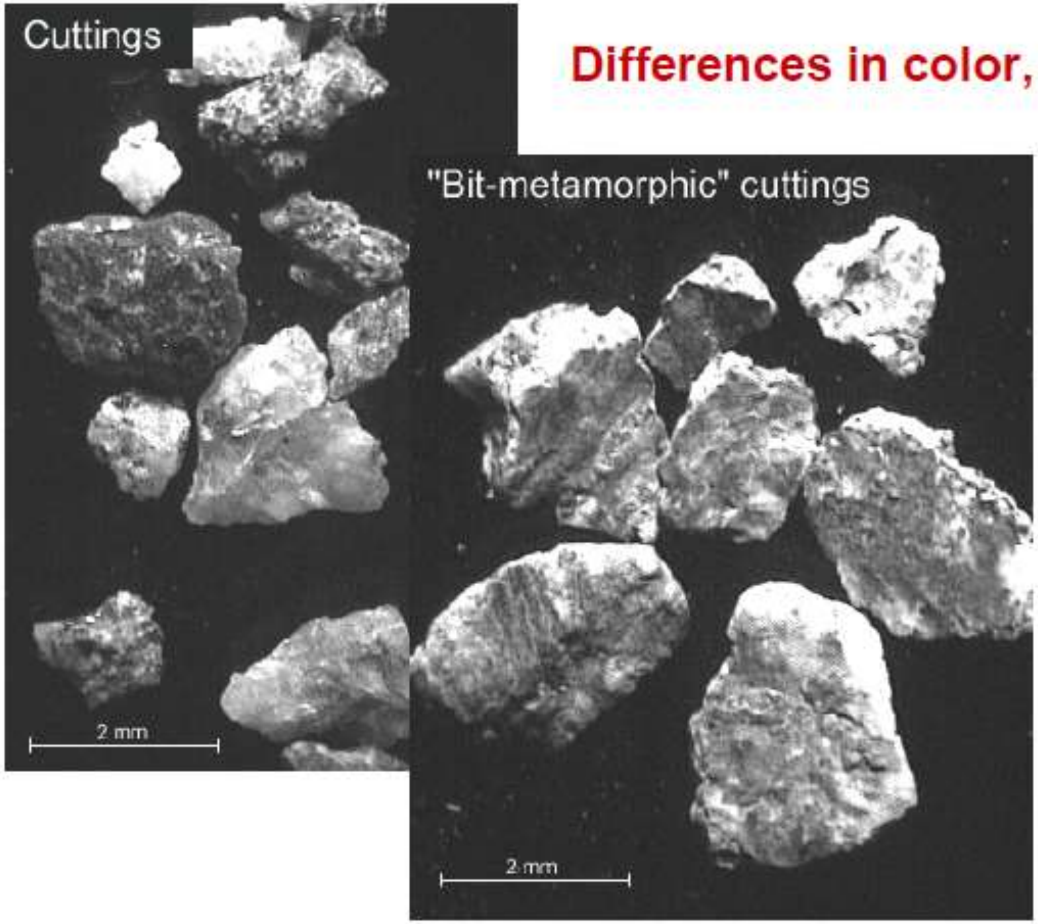
Reasons:

Hydraulic deconsolidation due changing of the mud conditions

Mechanical impacts caused by the bottom hole assembly

Cuttings vs. Cavings

Bit-metamorphism

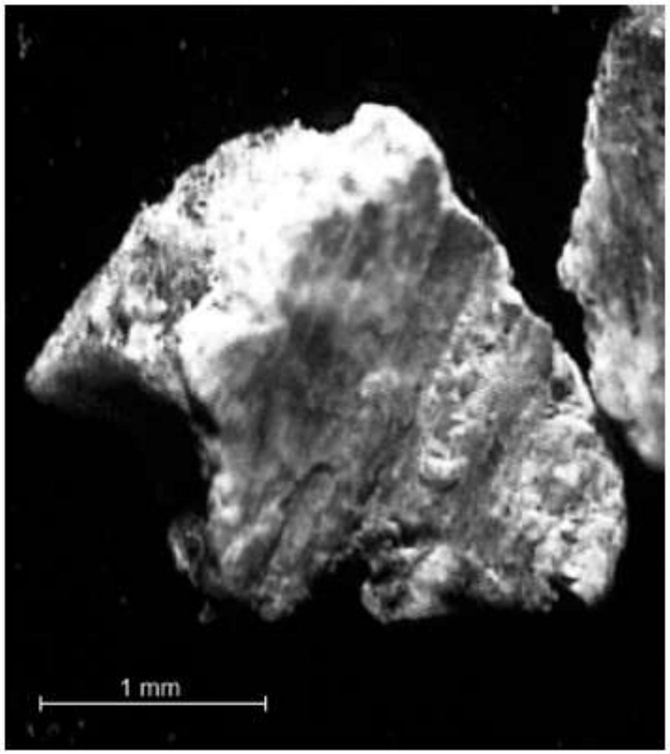


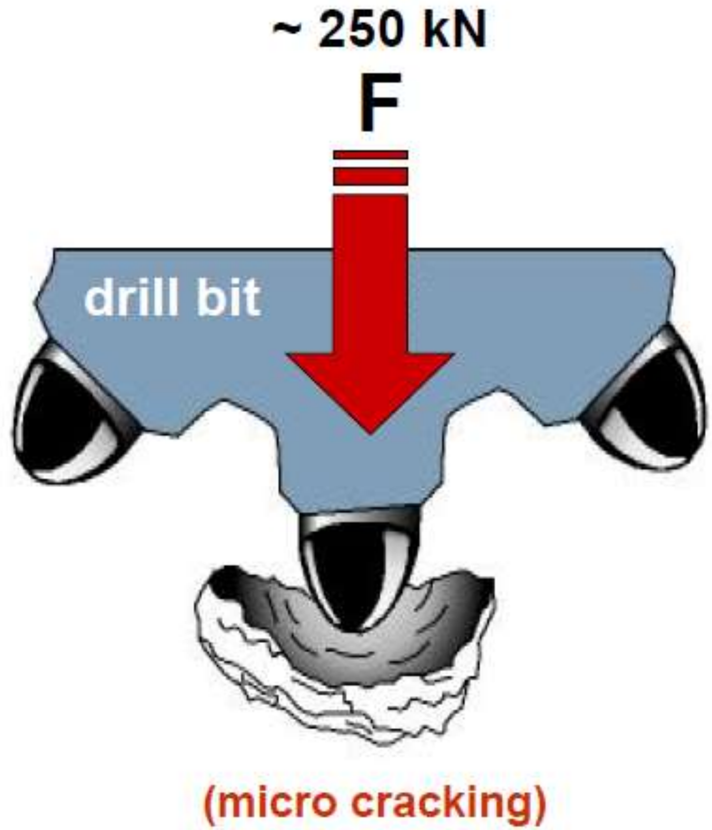
Differences in color, shape, and strength:

- brighter colors
- grayer dark colors
- convex/concave shape
- metallic striation
- low mechanical strength

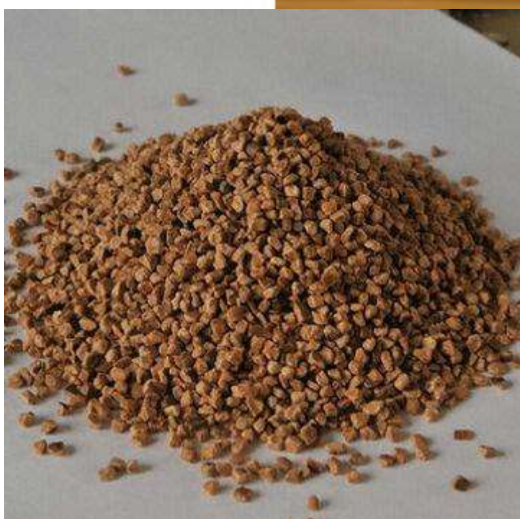
Cause of Bit-metamorphism

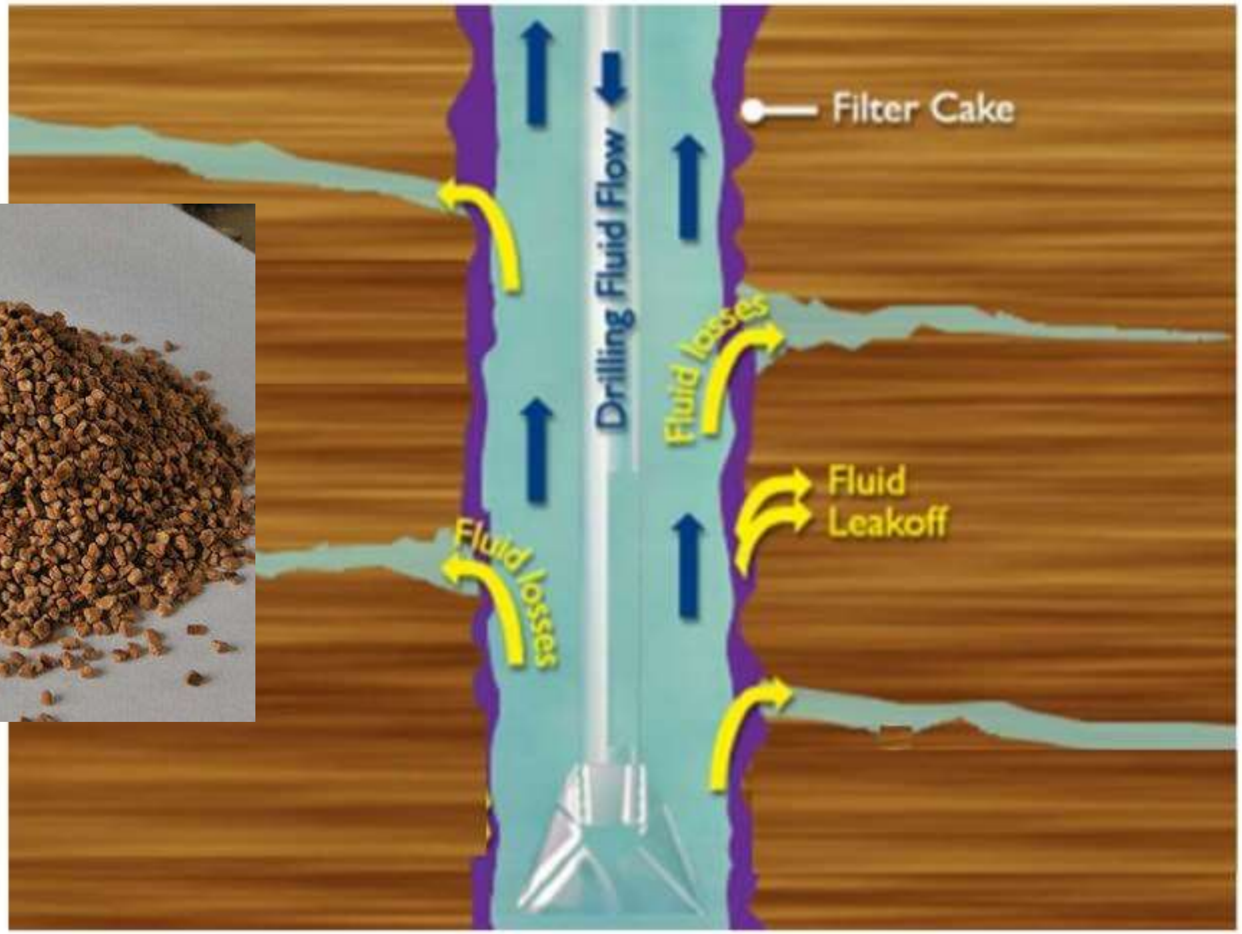
Digging and Dragging





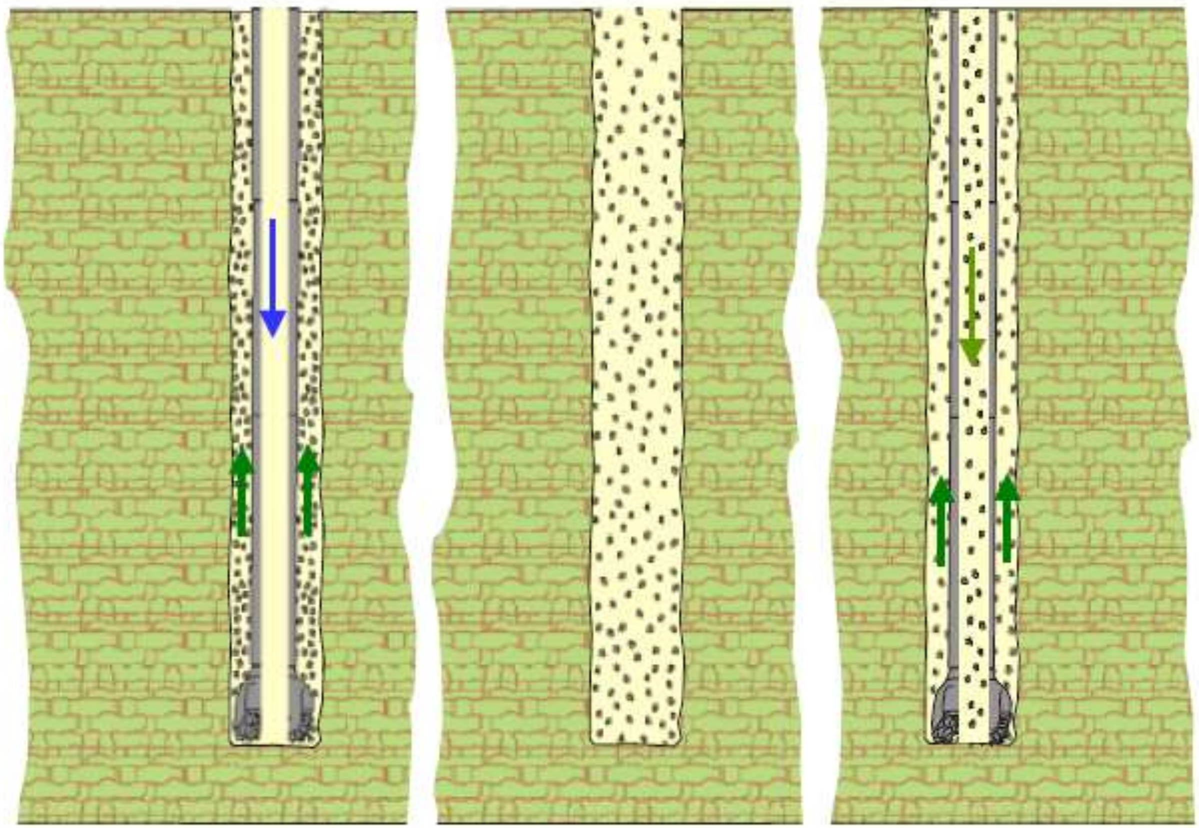
LCM materials





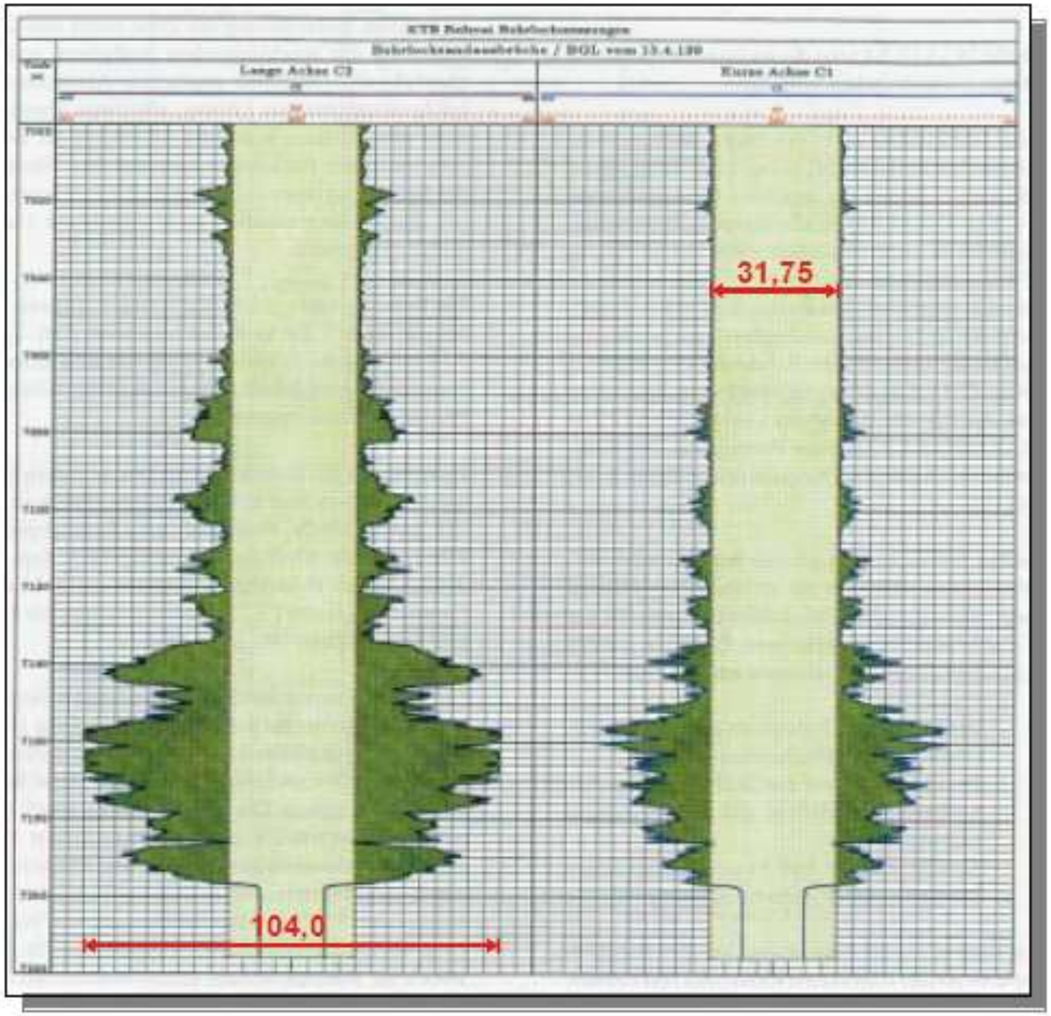
Cuttings from zones of lost circulation are often intermixed with lost circulation material.

Mixing of Cuttings During a Trip



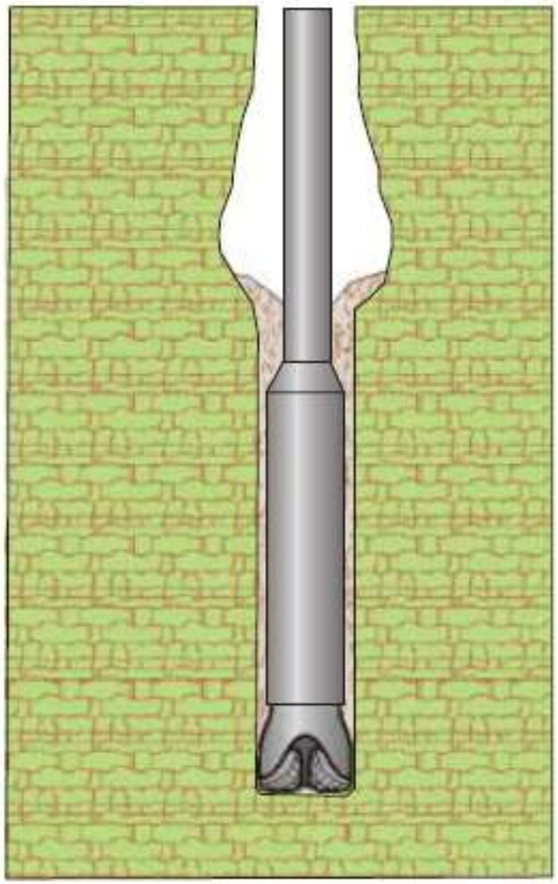
- Mud Viscosity
- When well is drilled at 1800ft it will take well cuttings takes 3hours up to the surface.

Borehole Break-Outs



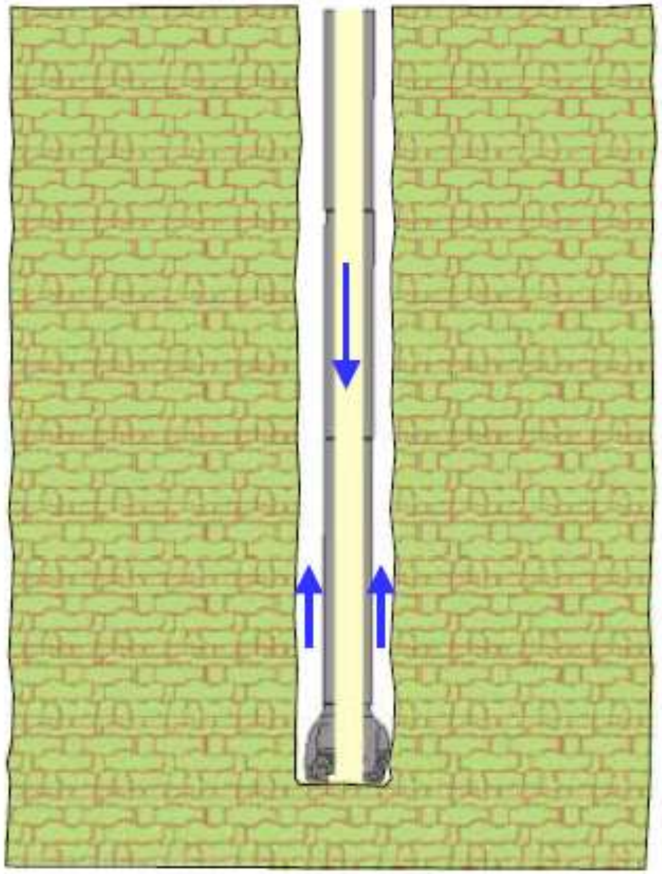
Various materials (such as whole oats, rice, barley or lentils) may be used as tracers and picked up on the shaker screen for approximating the lag.

Stuck Pipe



All irregularities have to be reported to the driller!

Bottoms-up



Solution:

Circulating the mud bottoms-up before tripping out!

But:

It needs additional time > money!

(2000 m drillhole approx. 22 minutes)

Sample Types

1) Wet Sample (unwashed):

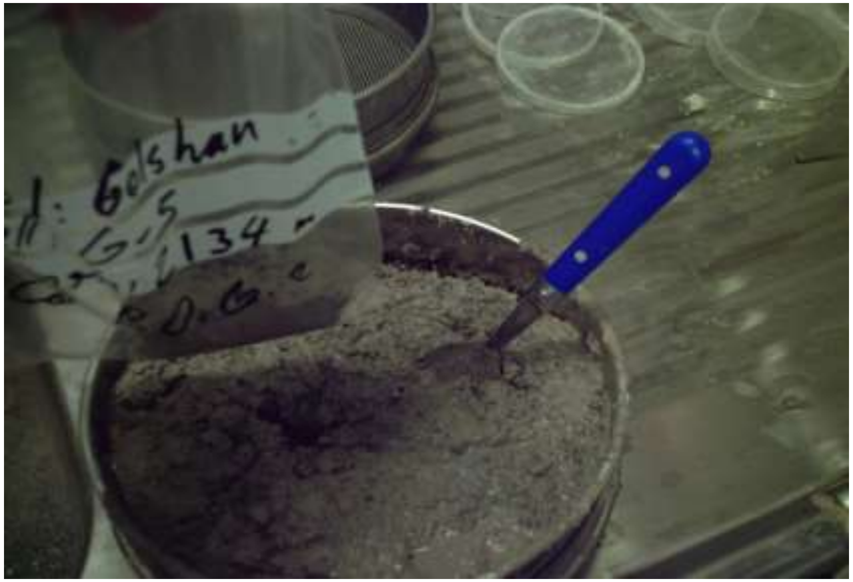
- ❖ Micropaleontological sample
- ❖ Palynological sample
- ❖ Petrographical sample

2) Dry Sample (washed):

- ❖ Stratigraphical sample (mud logging)
- ❖ Geochemical sample
- ❖ Geomechanical sample

Sample Catching

Sample Washing




Sample Drying

Cutting petrography

Cuttings Sample Description

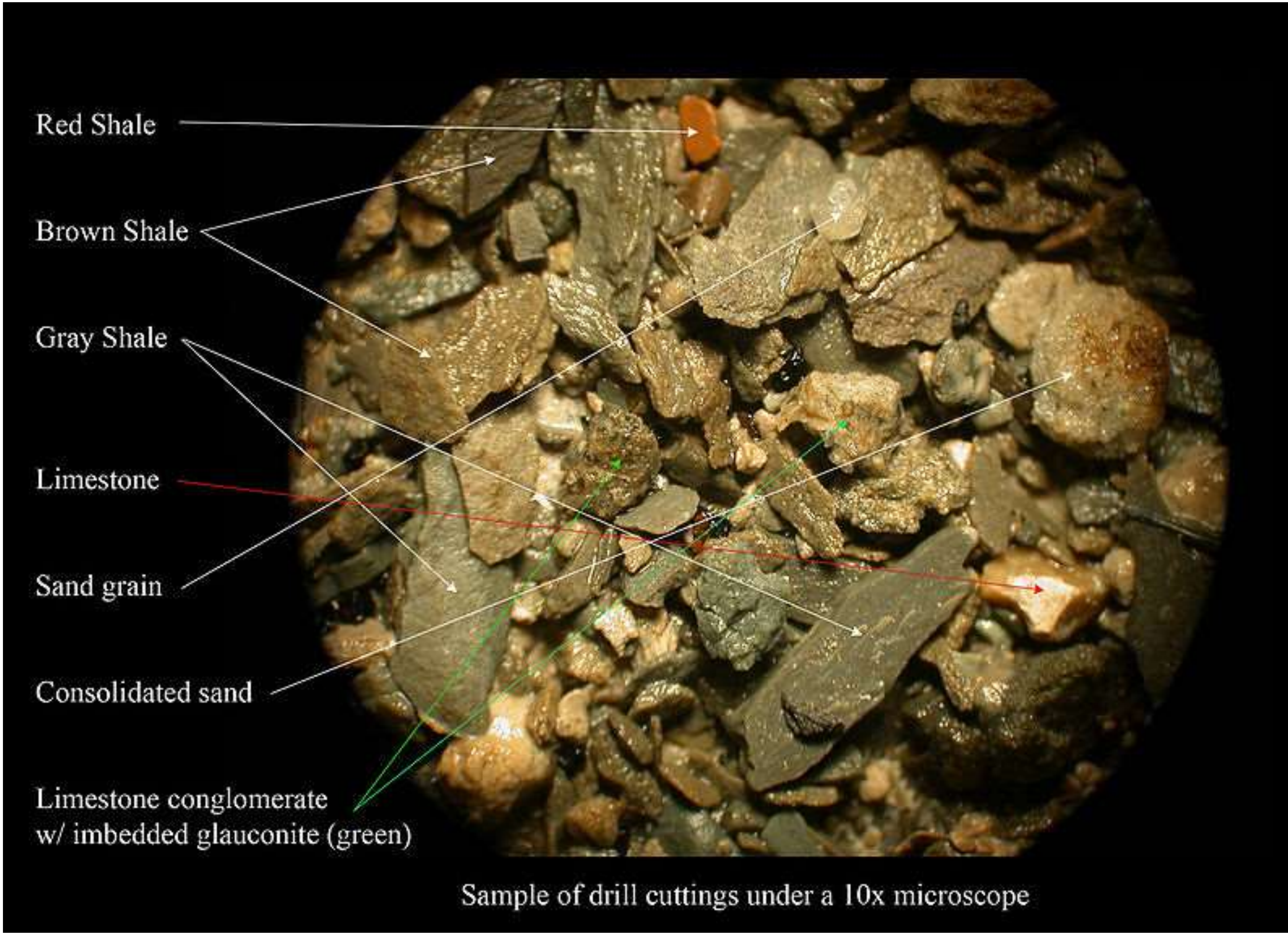
1. Rock name
2. Color
3. Hardness, fissility
4. Elements or grains

   Clastics
   - a. grain size
   - b. roundness
   - c. sphericity
   - d. sorting

   Carbonates
   - a. "grain" nature
   - b. "grain" size
5. Cement and matrix

   Clastics
   - a. abundance
   - b. nature

   Carbonates
   - a. abundance
   - b. crystallinity
6. Accessories, fossils
7. Visual porosity estimation
8. Hydrocarbon indications
   - a. visual (stains and bleeding)
   - b. direct fluorescence (extent, intensity and color)
   - c. cut fluorescence (rate, intensity and color)



Sample of drill cuttings under a 10x microscope