Drilling Problems

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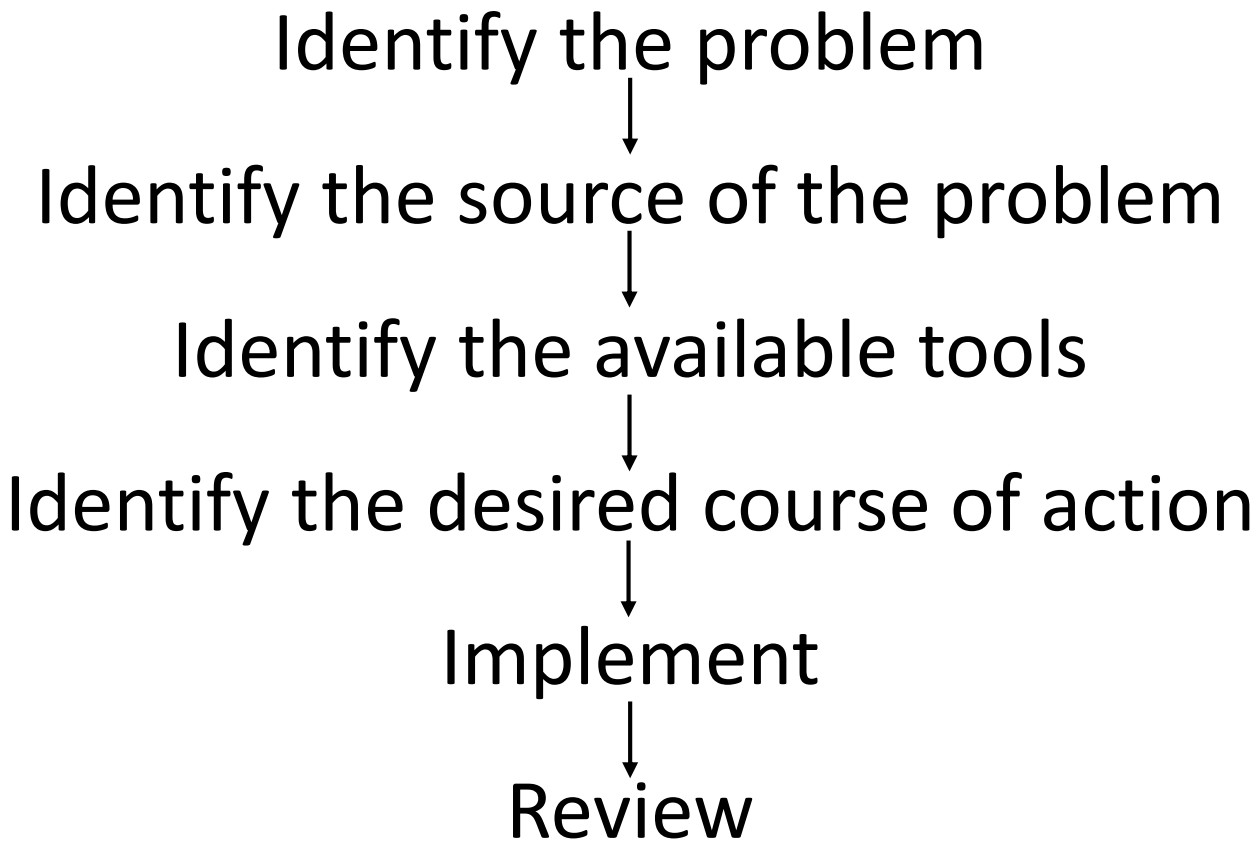
DRILLING PROBLEM-SOLVING

- **PROBLEM-SOLVING MECHANICS**



- **WHAT ARE TEAMS**
- Two or more people working together
- Work teams have a common goal
- Team members develop "earned trust" through accountability
- Teams are self-motivated
- Teams are performance motivated
- **TEAMS REQUIRE A MIXTURE OF SKILLS**
- Technical expertise
- Functional experience
- Problem solving capability
- Decision making skills
- Inter-personal skills

- Morale
- A measure seeking positive, confident, satisfied employees. Involves the overall viewpoint of employees while at work in the work environment. Includes employee emotions, attitude, satisfaction. The morale of the employees directly effects productivity. Dissatisfied and negative employees portray negative, low employee morale about their work environment. Positive or highly confident employees that are happy and positive at work are said to have high morale.

Communication:-

- ***Communication is defined as the imparting or exchanging of information and the sharing of ideas or feelings. It entails the process of creating meaning.***
- In order to keep a business operating well, it is essential to communicate effectively with employees. Employees need to be kept up to date with all aspects of the operation of the company. This includes communicating thoughts, feelings, and anything new that will be taking place, or that needs to take place.
- *Poor communication may well be the number one causes of drilling problems*.
- *We can measure morale by the amount of communication taking place*

1- Down hole problems

- A- stuck pipe
- When the drill string is no longer free to move up, down, or rotate as the driller wants it to, the drill pipe is stuck. Sticking can occur while drilling, making a connection, logging, testing, or during any kind of operation which involves leaving the equipment in the hole.
- Tight hole :Down hole force(s) restrict string movement above normal operating conditions (a usual warning indicator of a stuck pipe event)

MECHANISMS

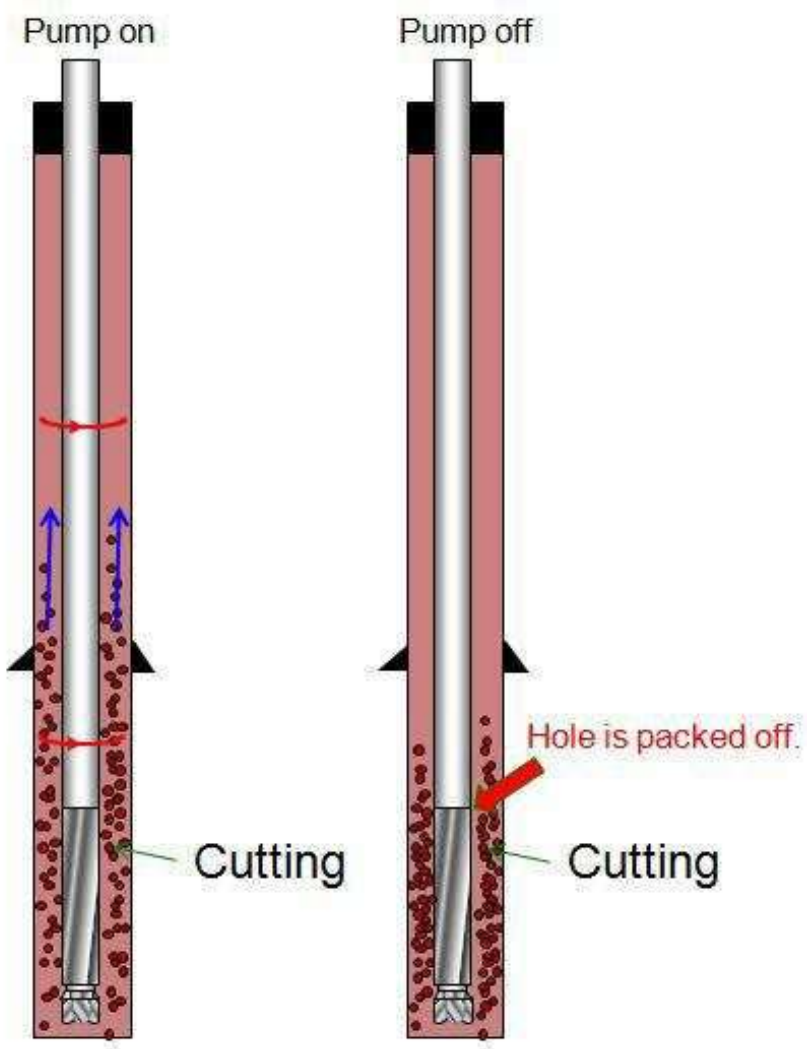
STUCK PIPE MECHANISMS		
HOLE PACK-OFF/BRIDGE	DIFFERENTIAL STICKING	WELLBORE GEOMETRY
SETTLED CUTTINGS	DIFFERENTIAL FORCE	STIFF ASSEMBLY
SHALE INSTABILITY		KEY SEAT
UNCONSOLIDATED FORMATIONS		MICRO DOGLEGS
FRACTURED FORMATIONS		LEDGES
CEMENT RELATED		MOBILE FORMATIONS
JUNK		UNDERGAUGE HOLE

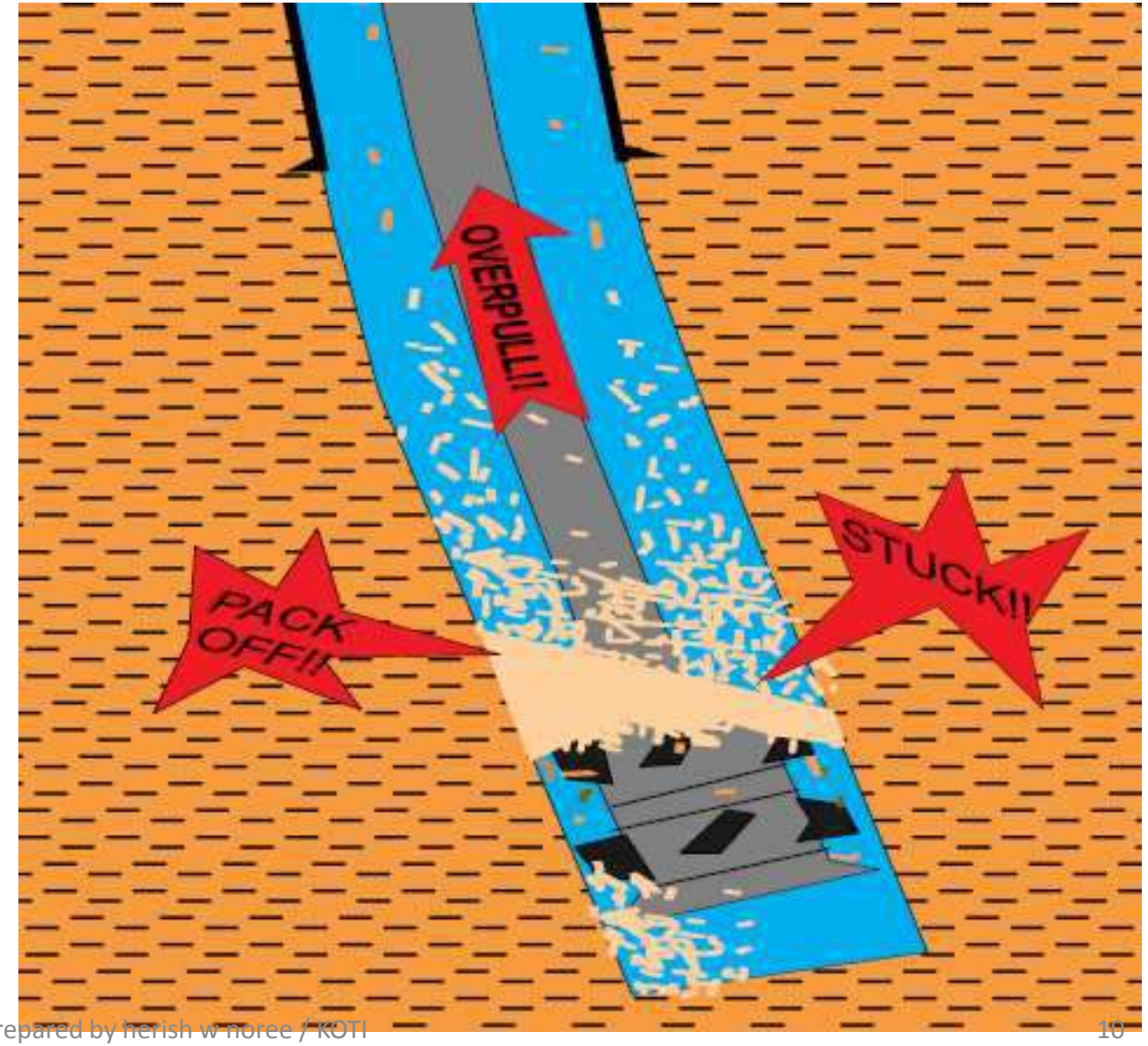
- **1- Pack off and bridging:** Pack off and bridging are occurred when there is something in the wellbore as formation cutting, junk, etc accumulating around drilling string/BHA and that stuff blocks the annulus between drill string and the wellbore. You should remember that either big or small debris can stick the pipe.
- According to statistics around the world, pack off and bridging is the most frequent cause of stuck pipe situation in the world. It normally occurs when the mud pumps are off for an extended period of time such as when pulling out of hole. It is quite a tough job to free the pipe in case of packoff or bridging and the chance of success is lower than differential or wellbore geometry sticking mechanism

1- Cutting settling in vertical wells < 35 degree

HOLE CLEANING IS AFFECTED BY 6 BASIC FACTORS	
FACTOR	**AFFECT**
RATE OF PENETRATION	*Determines the cuttings volume* in returning mud
HOLE STABILITY	*Cavings load added* to the returning mud
ANNULAR VELOCITY	*Lifts* the cuttings
MUD RHEOLOGY	*Suspend* and *Carry* the cuttings
CIRCULATING TIME	*Transport* the cuttings to surface
HOLE ANGLE	*Reduces* the ability to clean the hole

A- Settled cutting





CAUSE:-

- Drilled cuttings are not transported out of the hole due to low annular velocity and/or poor mud properties.
- When circulation is stopped, the cuttings fall back down the hole and pack-off the drill string.

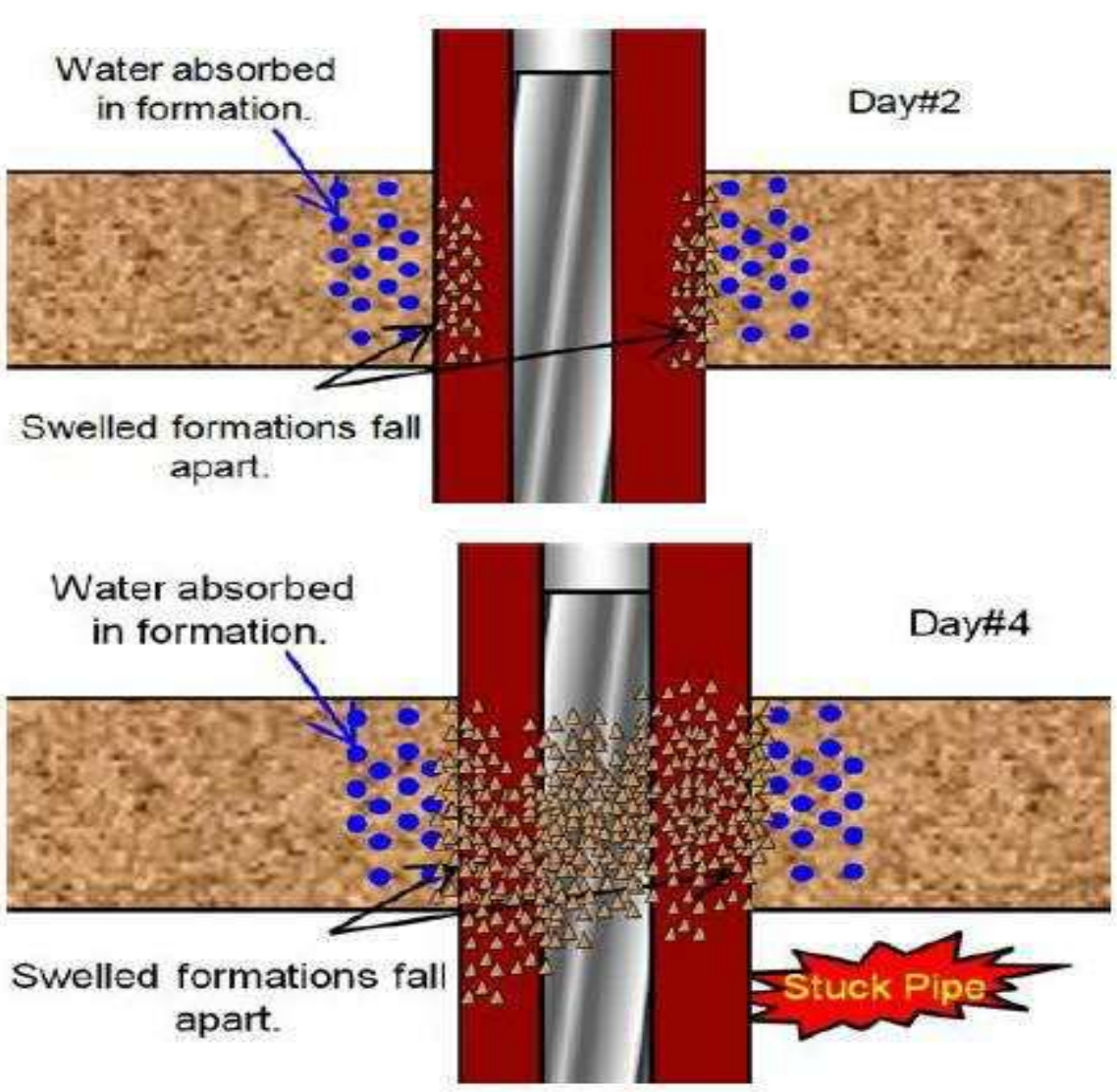
- **WARNING SIGNS OF CUTTING SETTING IN VERTICAL WELLS :-**
- High Rop, low pump rate, little to no circulating time at connections
- Torque, drag and pump pressure increase
- Over pull when picking up, pump pressure required to break circulating is higher without any parameters changes
- Fill On bottom

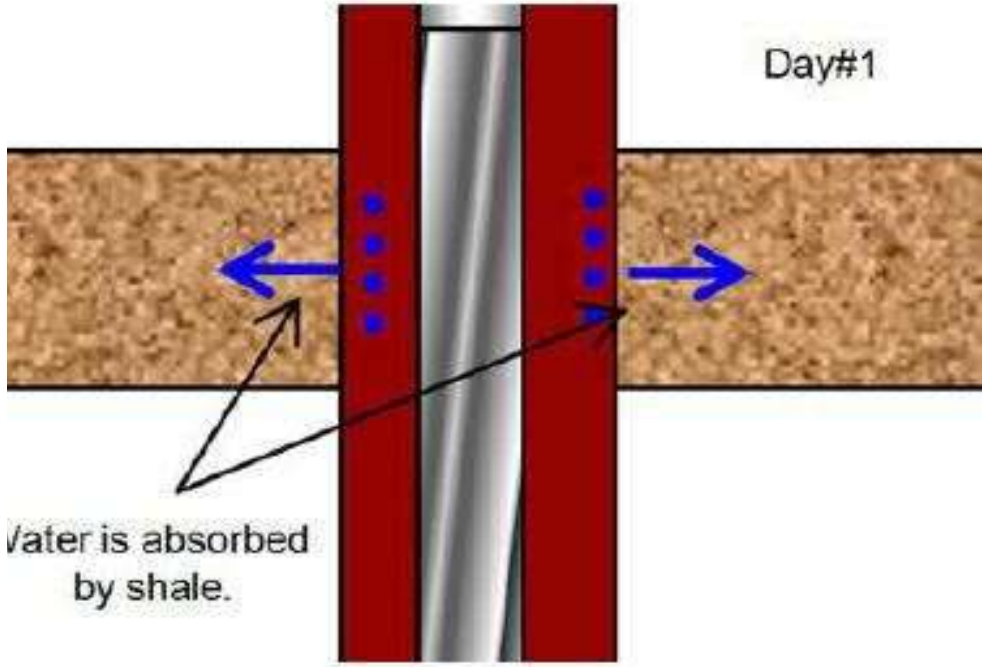
- **INDICATIONS WHEN YOU ARE STUCK DUE TO CUTTING BED IN VERTICAL WELLS**
- Circulation is restricted and sometimes impossible.
- It most likely happens when pump off (making connection) or tripping in/out of hole.

- ***FIRST ACTION:***
- **1.** Attempt to circulate with low pressure (300-400 psi). Do not use high pump pressure because the annulus will be packed harder and you will not be able to free the pipe anymore.
- **2.** Apply maximum allowable torque and jar down with maximum trip load. Do not try to jar up because you will create worse situate.
- **3.** Attempt until the pipe is free, then circulate and work pipe until the wellbore is clean. Check cutting at shale shakers, torque/drag and pump pressure in order to ensure hole condition.

- ***PREVENTIVE ACTION:***
- Control Rop, ensure that annular velocity is more than cutting slip velocity
- Maintain Sufficient gel strength and yp
- Circulate 5 to 10 minutes before connections
- Circulate hole clean before pooh

B- Shale Instability





- ***CAUSE:***
- Water in the mud absorbed by shale formations causes swelling effect on formations. When there is a lot of water, shale will not be able to hold their particles together and finally falls apart into the well. Finally shale particles will jam a drill string.
- The shale instability is a chemical reaction which is time dependent. It means that you may not see it on day one, you may see it after you have been drilling for days.

- ***WARNING:***
- funnel viscosity, pv, yp, increase
- torque & drag increase
- pump pressure increase
- clay balls and/or soft "mushy" cuttings at shaker
- Over pull & swabbing
- BHA balling

- ***INDICATIONS:***
- Generally occurs while pooh, possible while drilling .
- Circulation Impossible Or highly restricted .
- observe very high pump pressure at small rate .
- ***FIRST ACTION:***
- Apply low pump pressure (200 - 400 psi)Do not use high pump pressure because the annulus will be packed harder and you will not be able to free the pipe anymore.
- If pooh, torque up and jar down with maximum trip load
- IF RIH, jar up with maximum trip load, do not apply torque
- ***PREVENTIVE ACTION:***
- For water based mud – you may need to add some salts that compatible with a mud formula in order to reduce chemical reaction between water and shale. Moreover, you should consider adding some coating polymers to prevent water contact with formation.

. Use oil based mud instead of water based mud because oil will not react with shale.

- maintain mud properties
- plan wiper trips
- Keep good flow rate to ensure good hole cleaning

3- Unconsolidated Formation

CAUSE:

little or no filter cake

unbounded formation (sand, pea gravel etc.) can not be supported by hydrostatic overbalance

sand/pea gravel falls into the hole and packs off the drill string

WARNING:

This situation could happen either while drilling or tripping. There is more chance that the situation can happen while drilling.

Slightly loss may possibly be seen while drilling.

Drilling torque and pump pressure abnormally increase.

Abnormal drag can be observed while picking up pipe

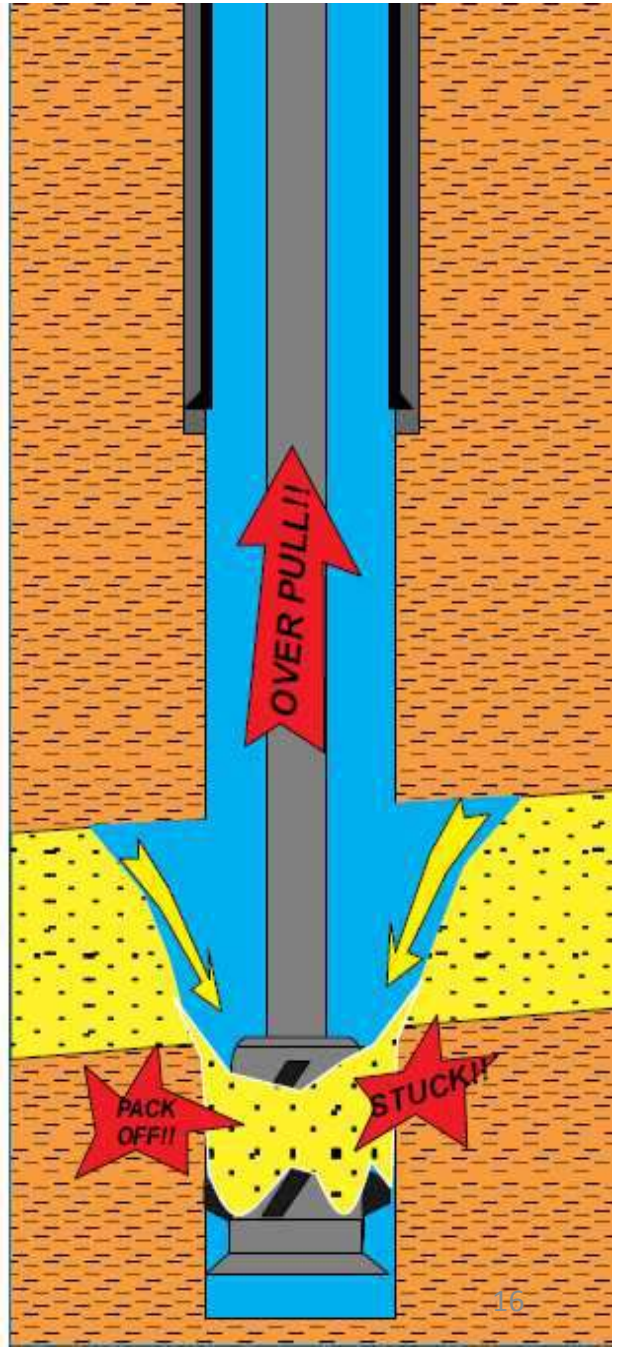
Indications:-

Observe a lot of particles of gravel, sand, pea over shale shakers.

Increase in mud weight, rheology and sand content in drilling mud.

When it happens, the annulus may be completely packed off or bridged off; therefore, circulation is very difficult or impossible to establish.

Most of the time this situation happens while drilling a surface section where formation bonding is not strong. Moreover, it can occur suddenly.



- ***FIRST ACTION:***
- Attempt to circulate with low pressure (300-400 psi). Higher pump rate is not recommended because it will cause more cutting accumulation around a drill string and your drill string will become harder to get free.
- If you are drilling or POOH, apply maximum allowable torque and jar down with maximum trip load.
- If you are tripping in hole, jar up with maximum trip load without applying any torque.
- . When the pipe is free, circulate to clean wellbore prior to drilling ahead.

- ***PREVENTIVE ACTION:***
- Use high vis/weight sweep to help hole cleaning.
- Ensure that fluid loss of drilling mud is not out of specification. Good fluid loss will create good mud cake which can help seal the unbounded formation.
- Control ROP while drilling into unconsolidated zones and take time to clean the wellbore if necessary.
- Slow tripping speed when BHA is being passed unconsolidated zones to minimize formation falling down.

. Minimize surge pressure by starting/stopping pumps slowly and working string slowly.

- Spot gel across suspected formations prior to tripping out of hole. Gel could prevent some particles to fall down into the wellbore

4-Fractured Formation

CAUSE:

Naturally fractured formations pieces of formation fall into the wellbore and jam the drill string.

WARNING:

Drill into potential naturally fractured zones as limestone, sand stone, carbonate, etc

likely to occur as formation is drilled

Mud logger formation evaluation

Blocky carvings at shaker

hole fill on connections and trips

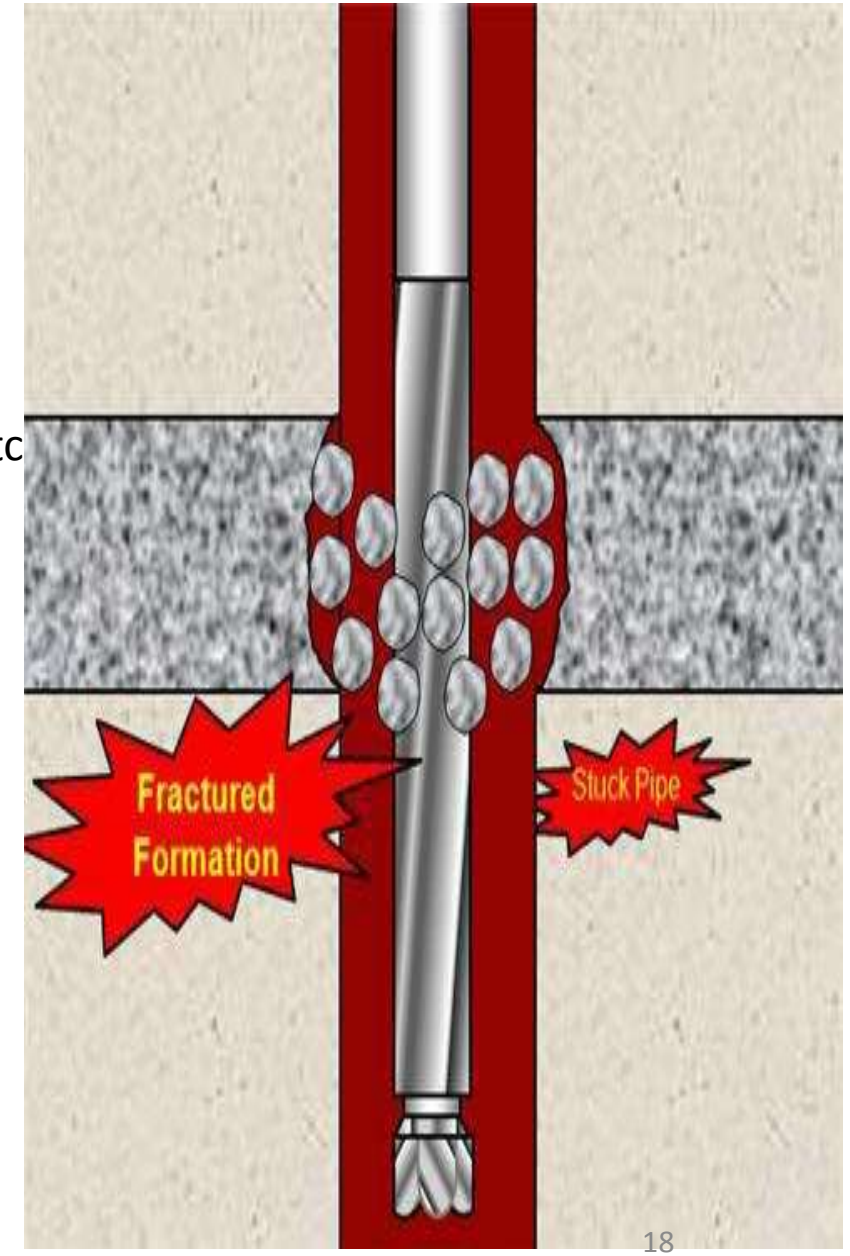
INDICATIONS:

likely during trips, possible while drilling

Sudden and erratic torque and drag

Over pull off slip is noticed.

Circulation could be restricted (you may get or not get good circulation



- ***FIRST ACTION:***
- Stuck while moving up, jar down with maximum allowable trip load without applying any torque!!!
- Stuck while moving down, jar up without apply torque
- Pump weighted hi-vis sweep with maximum allowable flow rate
- Spot acid if stuck in limestone
- ***PREVENTIVE ACTION:***
- circulate hole clean before drilling ahead
- minimize seepage losses
- slow trip speed before BHA enters suspected zone
- Start and stop circulation slowly to minimize surge pressure
- Keep mud in good shape. Good and thin mud cake can support fracture formation in some cases.

5- Cement Blocks

CAUSE:

Cement around casing shoe or open hole cement squeeze becomes unstable and finally chunks of cement fall into a wellbore. If there are a lot of cement chunks in the annulus, drilling string will be stuck.

WARNING:

Rat hole is too long

Drilling in to areas where open hole cement jobs as cement squeeze or kick off plug were performed

Cement carvings at shaker

INDICATIONS:

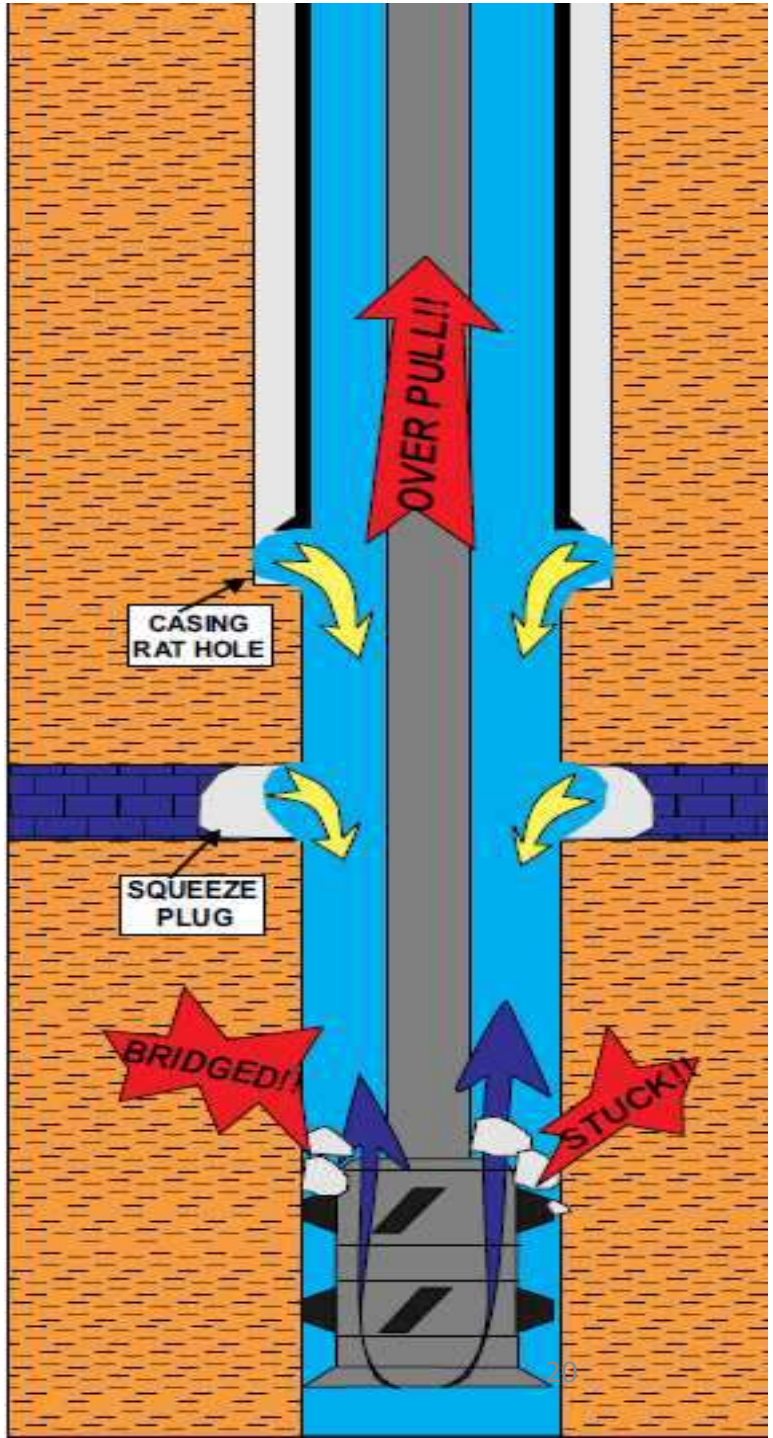
Cement chunks are seen at shale shakers.

There are cement content in mud logger samples.

Stuck pipe due to cement blocks can be occurred anytime.

Circulation is not restricted.

Torque and drag are drastically increased and erratic.



- ***FIRST ACTION:***

- Stuck while moving up, jar down with maximum allowable trip load. Gradually apply torque if required.

. Stuck while moving down, jar up without applying torque.

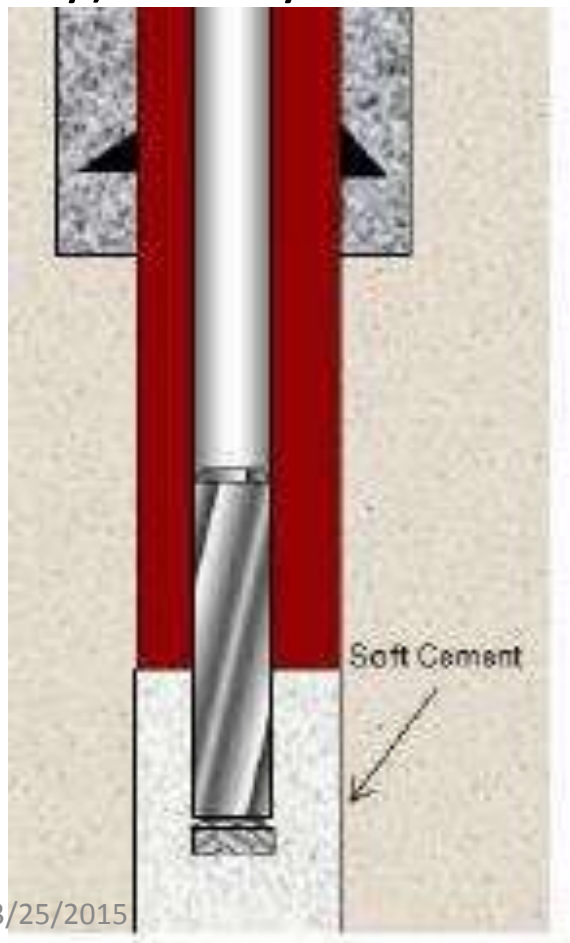
- Pump weighted hi-vis sweep with maximum allowable flow rate to clean large pieces of cement around drilling string/BHA

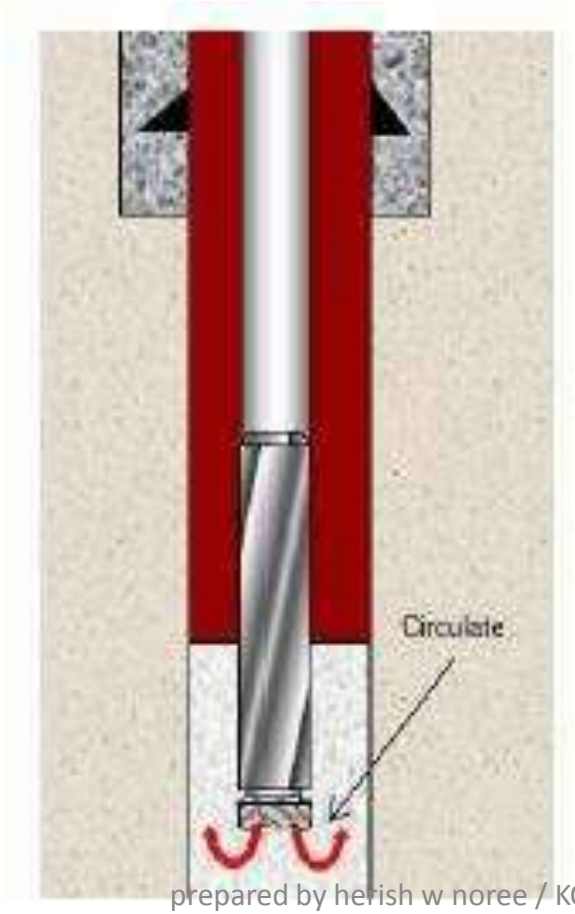
- **Preventive actions:**

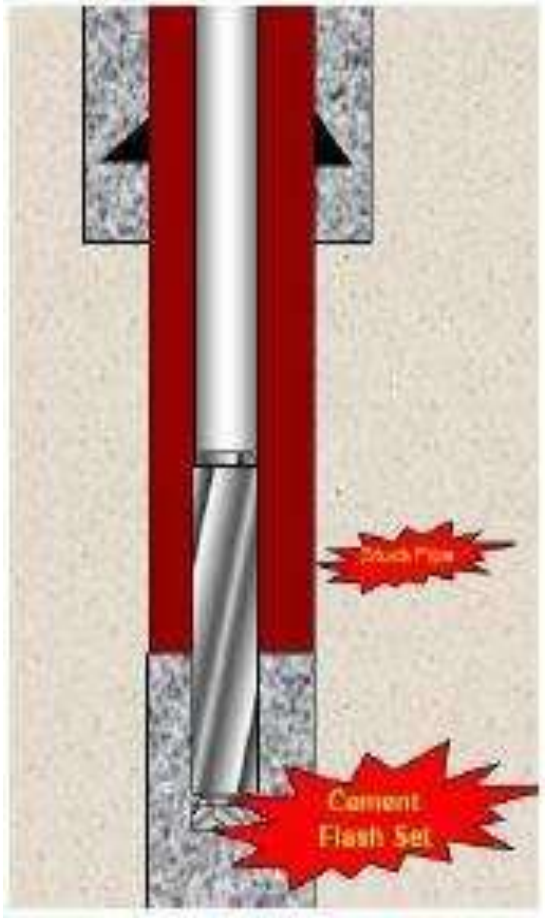
- . Do not leave a long rat hole.
- . Ream with circulation through casing shoe and areas where there is open hole cement.
- . Attempt to clean cement in the annulus prior to drilling.
- . Wait for cement setting long enough before drilling ahead.
- . Minimize tripping speed when BHA passes through casing shoe or cement plug/cement squeeze depth.

Soft Cement

- ***CAUSE:***
- The drill string/BHA is in soft cement and when circulation is established, pumping pressure causes the soft cement to flash set (cement becomes harder quickly). Finally the drill string gets stuck due to hard cement around it.







- **WARNING :-**
- Run in hole after the open hole cement job as cement balanced plug is completed.
- Unable to see firm cement while attempting to find the theoretical top of cement. It indicates that you may be in the soft cement

- ***INDICATIONS:***
- Happens when pump pressure is brought up and pump pressure increases quickly.

  . Rotary torque suddenly increases.
- When the soft cement is flash set, you may not be able to get circulation or get low circulation at very high pump pressure

- ***FIRST ACTION:***

- First of all, before jarring operation, you must bleed off trapped pressure in the string.
- Apply jar with maximum trip load. Jar at the opposite direction of string movement. For example, if you are stuck while moving up, you need to jar down. On the other hand, you need to jar up, if you are stuck while moving down.

- **Preventive actions:**

- **.** Ensure that cement is properly set prior to tripping to top of cement.
- **.** Stop at least 100 ft above the calculated top of cement and establish circulation prior to tag top of cement.
- **.** Tag cement slow with pump on.
- Don’t clean out cement too fast. Attempt to control drill and check pick up/slack off weight and torque frequently while drilling out cement

JUNK IN THE HOLE

CAUSE:

Junk from the surface drops into the wellbore casing stuck pipe. It could be happened due to several factors as poor housekeeping on the rig floor, rotary table not covered, surface/down hole equipment failure.

WARNING:

Observe equipment on surface falling downhole

If down hole equipment failure, the drill string gets jammed suddenly without any sings.

Stuck pipe by the junk can be occurred any time.

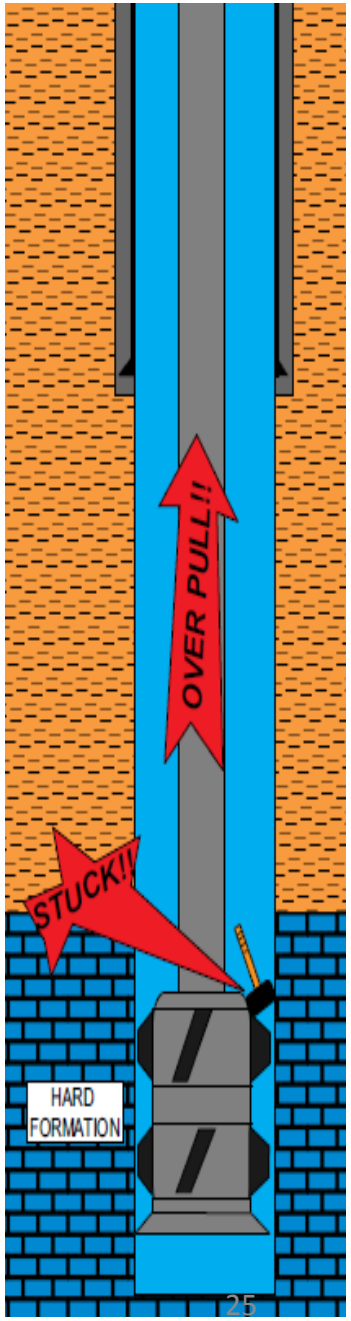
Suspicious substance as metal, wood, rubber may be found at the shale shaker

INDICATIONS:

Torque suddenly becomes erratic.

Drag increases

Equipment on the rig floor falls down hole



- ***FIRST ACTION:***
- If you get stuck while moving up, jar down with maximum trip load. Torque may be applied with caution.
- If you get stuck while moving down, jar up without any toque applied in the drill string

- **Preventive actions:**
- Maintain good housekeeping on the rig floor
- Ensure that hole cover is used all the time when work on rotary table.
- Maintain tool used on the rig floor in a good condition.
- Inspect downhole tool prior to tripping in hole

- **What should you do to free the stuck pipe caused by Pack off / Bridging?**
- Circulate with low flow rate (300 – 400 psi pumping pressure). This is very important to apply low flow rate because if high flow rate is applied, the stuck situation becomes worse.

- If the drill string gets stuck while moving up or with the string in static condition, jar down with maximum trip load and torque can be applied into drill string while jarring down. DO NOT JAR UP. Be caution while applying torque, do not exceed make up torque.

- On the other hand, if the drill string gets stuck while moving down, jar up with maximum trip load. DO NOT apply torque in the drill string while jarring up.
- To free the string, jarring operation may take long time (10 hours +) so please be patient.

- **What should you do after the string becomes free?**

- Increase flow rate and circulate to clean wellbore at maximum allowable flow rate. Flow rate must be more than cutting slip velocity in order to transport cuttings effectively.

- Reciprocate and rotate while circulating to improve hole cleaning ability. Work the drill string with full stand if possible.

- Ensure that the wellbore is clean prior to continuing the operation. You can see from the sale shaker whether the hole is clean or not.

- Sweep may be utilized to improve hole cleaning.

- Back ream or make a short trip through the area where causes the stuck pipe issue.

- **Differential sticking:** Differential sticking happens when drill string is pushed against permeable formations by differential pressure between hydrostatic and formation pressure. The frictional force between drill string and formation is so high that you will not be able to move the pipe. The differential sticking tends to easily happen when drilling through depleted reservoir is conducted. Moreover, this stuck mechanism almost always happens when the drill string has been stopped moving for a long time.

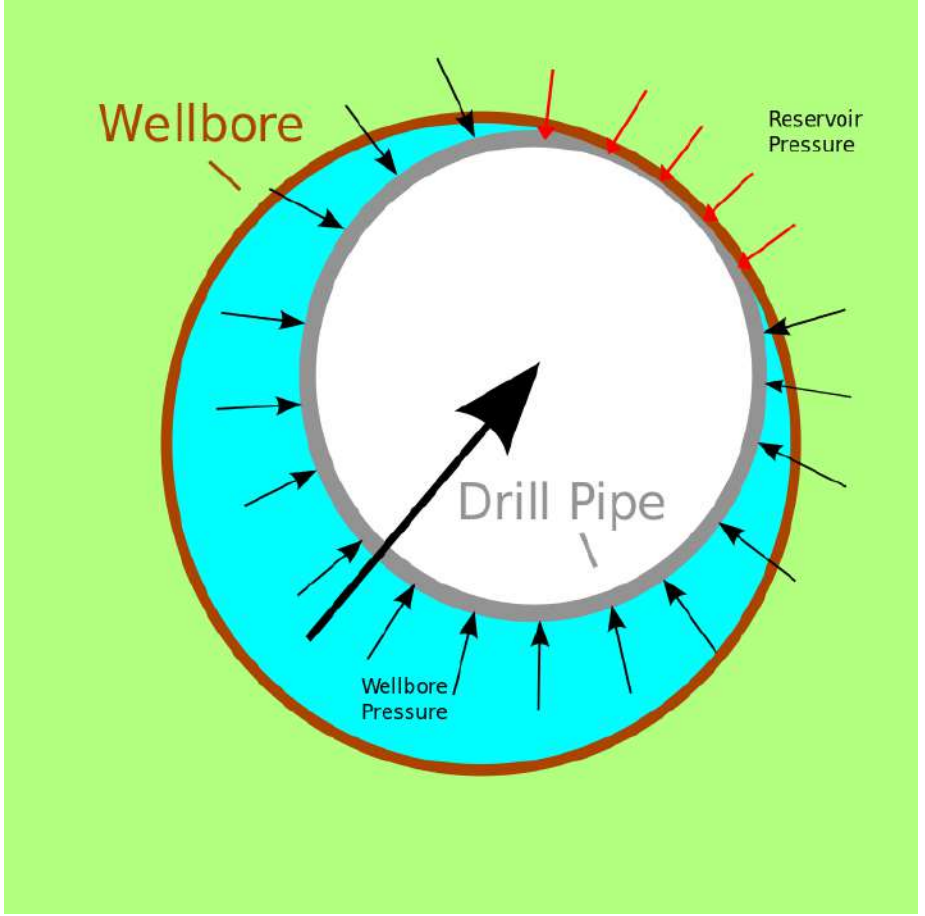
DIFFERENTIAL STICKING

CAUSE:

Drill string contacts a permeable zone

When string movement stops, a static filter cake develops

High overbalance applies a differential sticking force to the drill string contact area



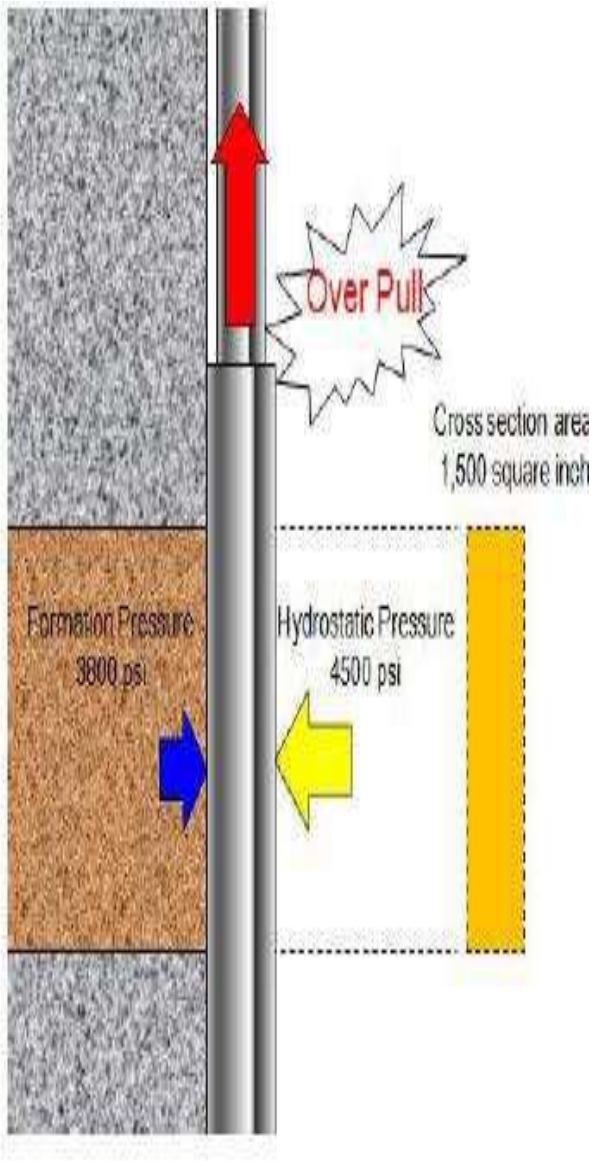
WARNING:

There are high over balance between wellbore and formation. Especially, when there is highly depleted formation, the chance of getting differentially stuck is so high. Torque, pick up and slack off weight increase when the drill string is being moved. Once it happens, you may not be able to pull or rotate pipe.

- ***INDICATIONS***
- occurs after a period of no string movement
- string can not be rotated or moved
- circulation unrestricted
- **FIRST ACTION:**
- Apply torque into drill string and jar down with maximum allowable trip load
- Jar up without apply torque
- Spot light weight pill to decrease hydrostatic pressure. If you want to the light weight pill, you must ensure that the overall hydrostatic pressure is more than formation pressure. Otherwise, you will face with a well control situation
- **PREVENTIVE ACTIONS:**
- Do not use too high mud weight
- Do not stop moving string for a period of time, especially, when the BHA is across formations.
- Keep mud in good shape. Under specification drilling mud will create thick mud cake which can be a big impact for the differential sticking.
- Minimize length of BHA and use spiral drill collar and heavy weight drill pipe to reduce contact area

- **Let's see how much differential force from this situation**
- Formation pressure = 3800 psi Hydrostatic pressure =4500 psi Cross area of stuck pipe = 1500 in2

Force = Differential Pressure x Cross Section Area
Where;
Force is in lb.
Differential pressure is in psi.
Cross section area is in square inch.
Force = (4500 – 3800) x 1500
Force = 1,050,000 lb
This is massive !!!
If we assume a coefficient friction of 0.5, you can determine how much tension you need to free the pipe.
From the basic of physic,
F= coefficient friction x N
Where;
F is force to pull.
N is reactive force.
For this scenario, N is equal to differential force.
F = 0.5 x 1,050,000 = 525,000 lb
You need overpull of 525,000 lb to free the pipe from this situation.



- These following guidelines help you free stuck drill string caused by differential sticking. :
- **The first action that you should do to free the stuck pipe caused by differential sticking.**
- Apply maximum flow rate as much as you can.
- Apply maximum torque in the drill string and work down torque to stuck depth. Torque in the string will improve chance of free the pipe.
- Slack off weight of string to maximum sit down weight.
- Jar down with maximum trip load. Torque may be applied with jarring down with caution. The chance of freeing the pipe by jarring down is more than jarring up. Please be patient when a hydraulic jar trips because it may take around 5 minutes each circle.

- **The secondary action to free the pipe that you may try**
- Reduce hydrostatic pressure by pumping low weight mud/pill. You must ensure that overall hydrostatic pressure is still able to control reservoir fluid to accidentally come into the wellbore.
- Continue jarring down with maximum trip load and apply torque into drill string.
- It may take long time to free the pipe therefore personnel must be patient
- **What should you do after the string becomes free?**
- Circulate at maximum allowable flow rate. Flow rate must be more than cutting slip velocity in order to transport cuttings effectively.
- Reciprocate and work pipe while cleaning the hole. Ensure that you can work pipe with full stand or joint while circulating.
- Condition mud prior to drilling ahead because if you still drill with poor mud properties, the differential sticking will be re-occurred.

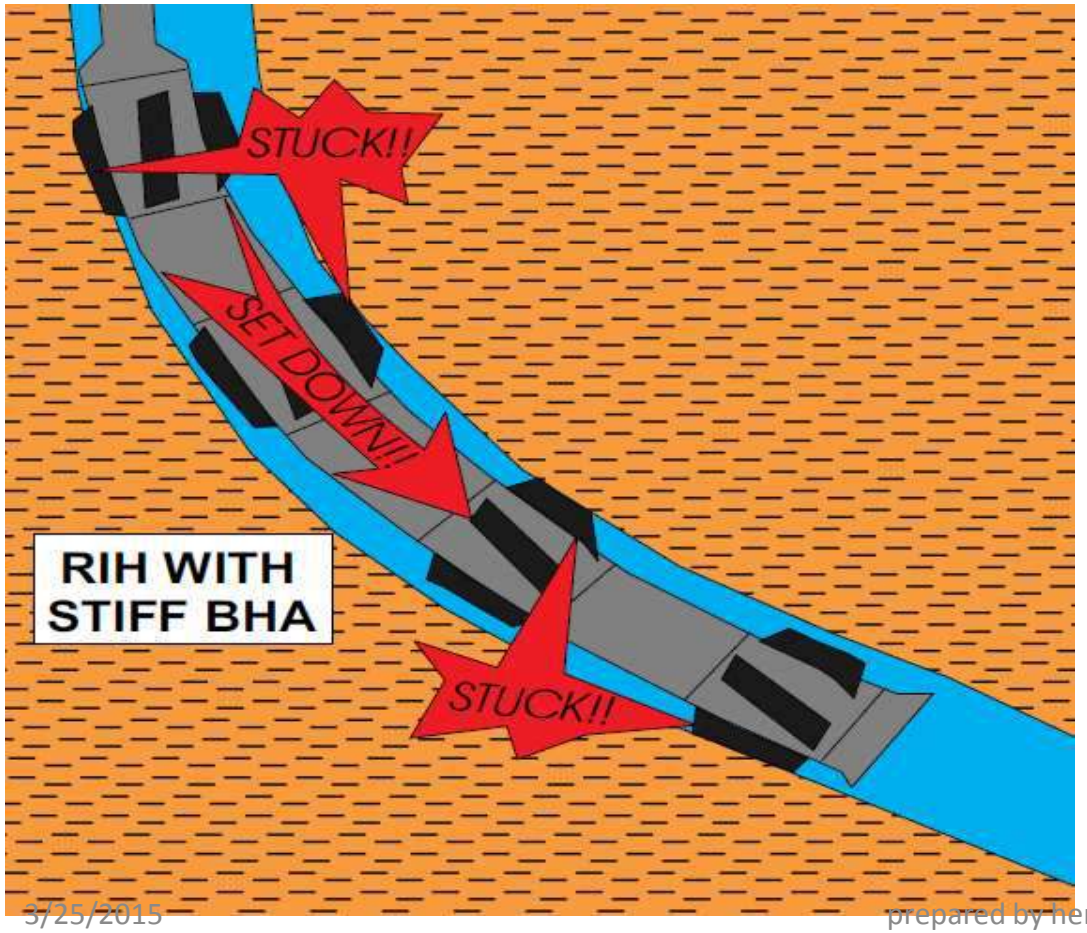
- **3- Wellbore geometry:**

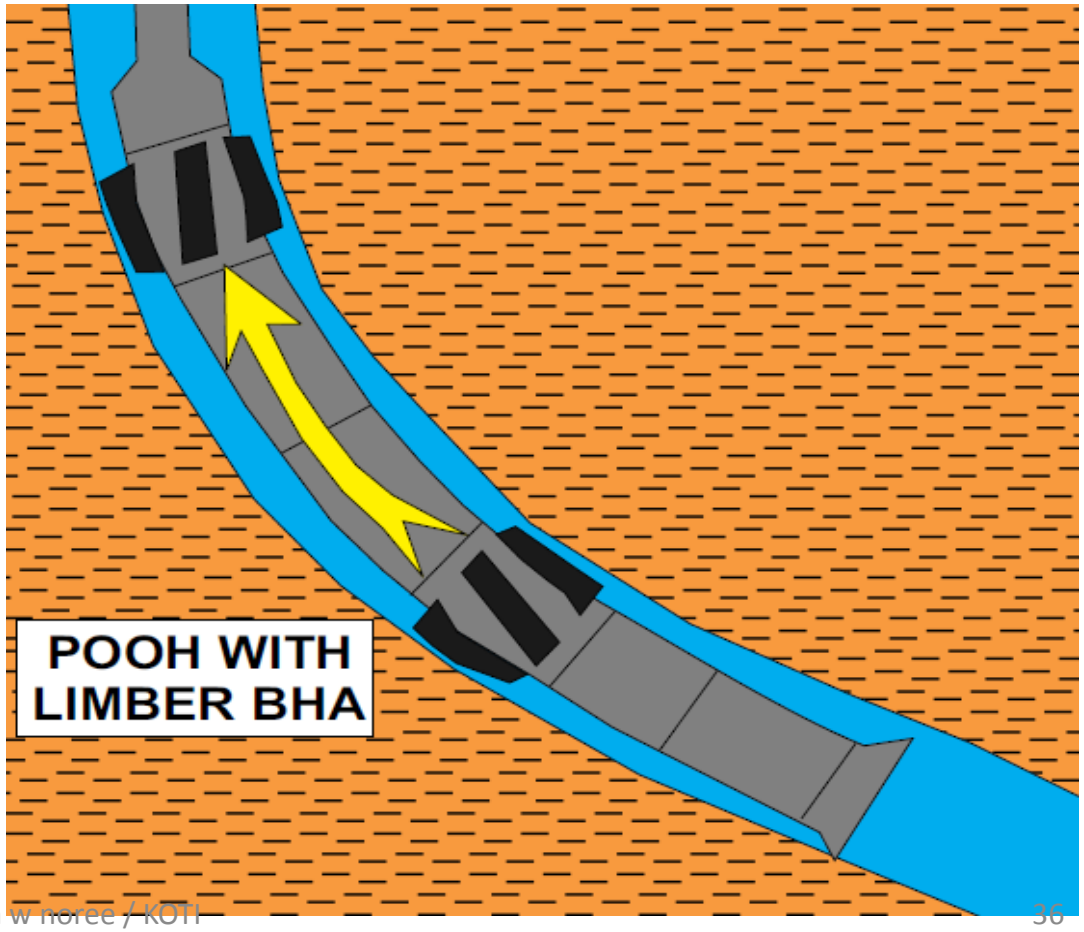
- Wellbore geometry stuck pipe mechanism occurs when the shape of the well and the bottom hole assembly (BHA) don’t match each other. Therefore, the drill string is not able to pass through that section.

A- STIFF ASSEMBLY

CAUSE:

the well is drilled with limber BHA. when the limber BHA is pulled out and the stiffer BHA is used as the next BHA, the stiff BHA is unable to pass the existing hole due to excessive dog leg and finally the BHA gets stuck.





Warning :

- Excessive dog leg severity is drilled.
- The Pulled BHA is under gauge.
- While tripping in hole with new BHA, sudden sit down weight is seen.

INDICATIONS:

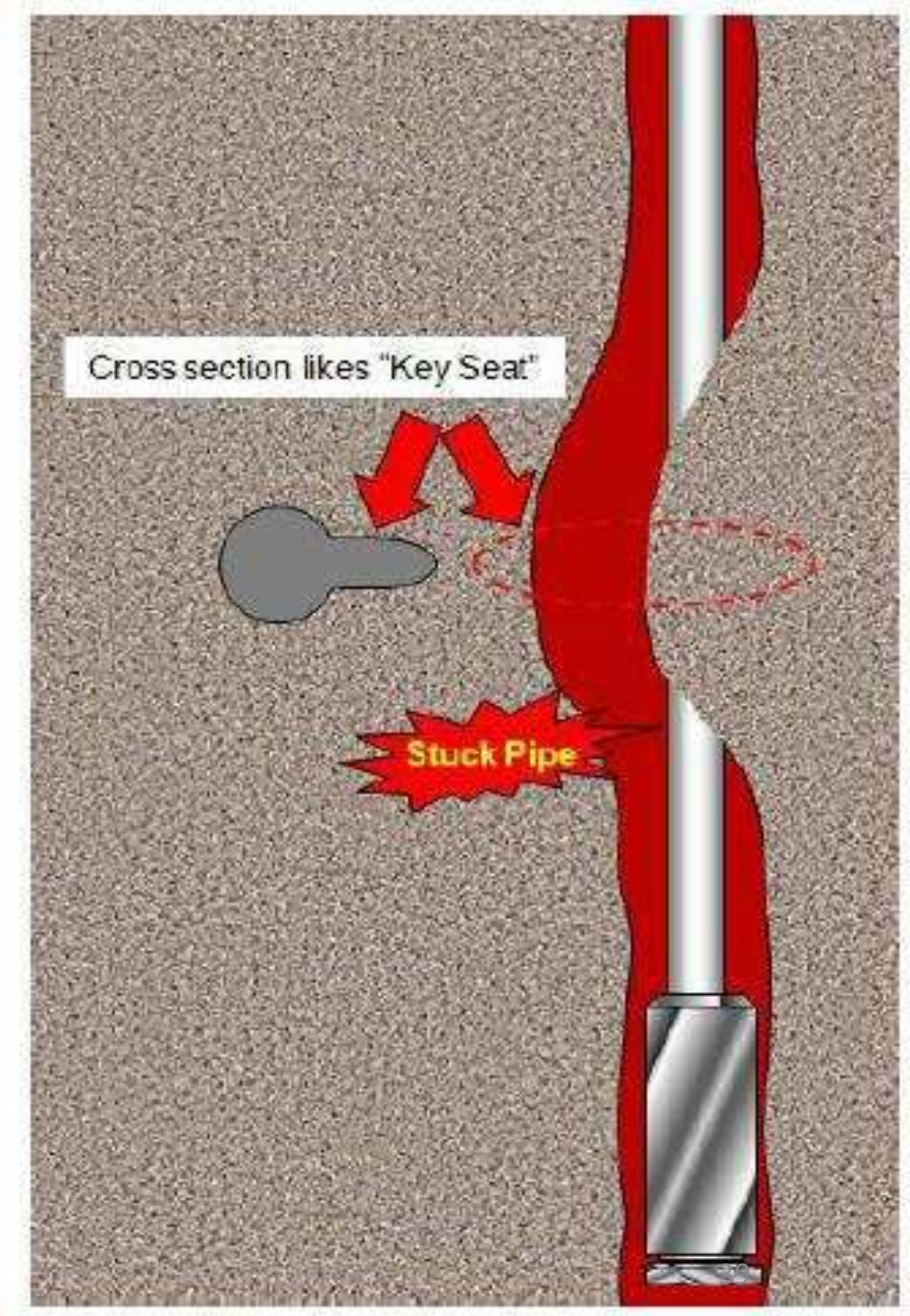
- The BHA has a possibility to get stuck at high dog leg areas.
- It is most likely occurred while running in hole.
- Circulation is not restricted .

- **FIRST ACTION:**
- If you get stuck while moving up, jar down with maximum trip load. Torque may be applied with caution.
- If you get stuck while moving down, jar up without any toque applied in the drill string.
- **PREVENTIVE ACTIONS:**
- Do not drill with a lot of dog leg severity
- Minimize changes in BHA configuration
- If the stiffer is used, you may need to ream in hole passing through high dog leg areas. Moreover, tripping/reaming speed must be limited prior to entering high risk zones.
- Do not create a lot of sit down weight to minimize BHA jammed.

B- KEY SEAT

- **CAUSE:**

- While drilling, with high tension and torsion in a drilling string, the drill string creates wear, called “key seat”, at wellbore where there are changes in direction. The soft to medium hard formation has a great tendency to get key seat. While pulling out of the hole, BHA gets stuck into the key seat.



Warning :

- High angle dogleg in upper hole section
- long drilling hours with no wiper trips through the dogleg section
- Cyclic over pull at tool joint intervals on trips

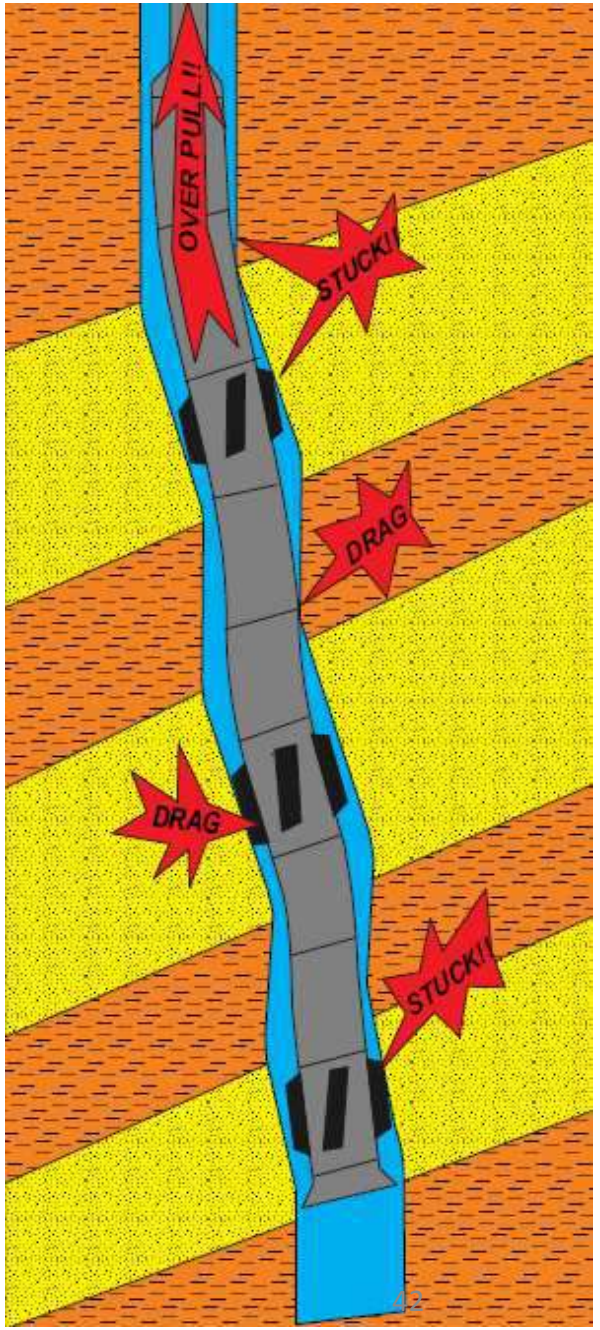
- **INDICATIONS:**
- This situation is occurred when pulling out of hole only.
- Circulation is not restricted.
- High over pull is suddenly seen when the BHA is pulled into the key seat.
- Tripping back is possible.

- **FIRST ACTION:**
- Because the drill sting gets stuck while moving up, jar down with maximum trip load must be applied. Torque while jarring down can be applied as well.
- Bring the rotation at slow speed and attempt to ream back with small over pull into the key seat areas.
- **PREVENTIVE ACTION:**
- Do not drill with a lot of dog leg severity 3 /100' or less
- Back ream some areas where high dog leg severity is presented.
- Run short trip or wiper trip to minimize the key seat.
- Utilize a reamer to high dog leg zones.

C- Micro Dogleg

CAUSE : -

Micro dogleg is occurred in areas where there are several corrections in inclination and azimuth and it most likely happens in hard/soft interbedd rock. If there are micro dogleg areas in the well, the bottom hole assembly can get stuck



Warning:

Hard and soft streak formations are drilled. You can easily observe from changes in ROP.

Inclination and azimuth are frequently changed.

Drilling the well with a mud motor causes this issue because of rotating and sliding operation.

- **IDENTIFICATION :**
- Drilling torque and drag are erratic.
- It can be happened while tripping or drilling.
- Circulation can be established without any restriction
- **FIRST ACTION:**
- If the drill string is stuck while moving up, jar down with maximum trip load. Torque can be applied with caution while jarring down.
- If the drill string is stuck while moving down, jar up with maximum trip load without applying any torque in drill string.
- If the drill string is free, you may need to consider back reaming to clear micro dogleg.
- **PREVENTIVE ACTIONS:**
- **1.** Minimize changes in inclination and azimuth
- **2.** Back ream operation should be performed when hard/soft streak is drilled.
- **3.** Slow down tripping sleep when entering possible problematic zones.

D- Ledges

CAUSE :-

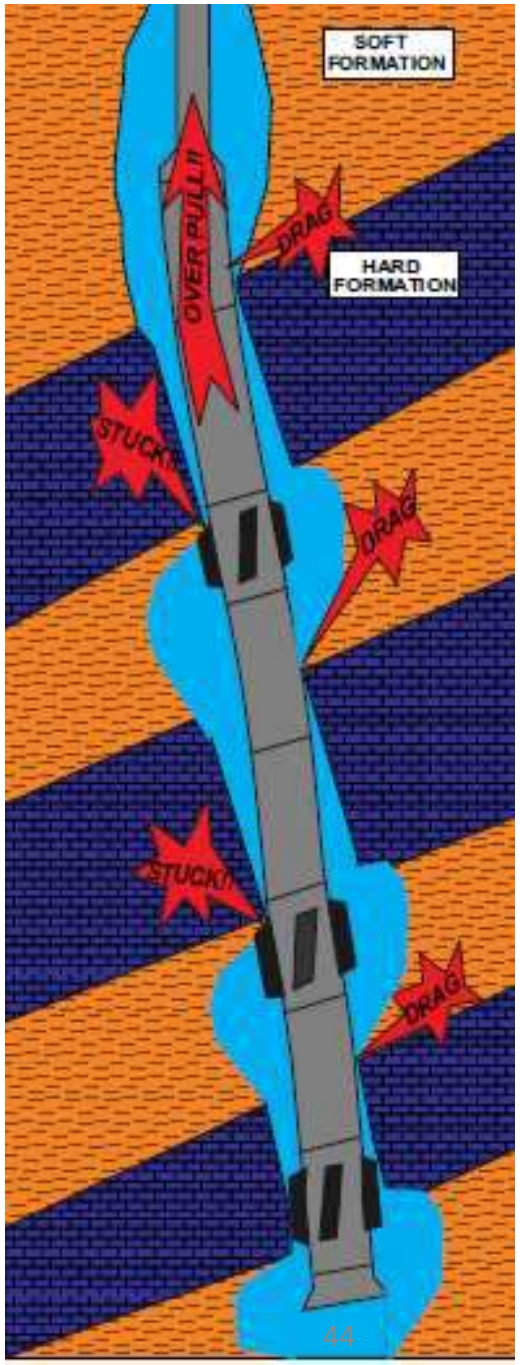
Ledges are occurred while drilling in sequential formations which have soft, hard formations, and naturally fractured formations. Stabilizers in BHA and tool joint easily wear soft formations and naturally fractured formations, however, the hard formations are still in gauge (hole size not change). If there are a lot of ledges in the wellbore, the drill string can get stuck under ledges

WARNING :

Hard and soft streak formations are drilled. You can easily observe from changes in ROP.

Mud logging samples show soft and hard rocks.

There is potential for fractured formations to be drilled.



IDENTIFICATION:

- Erratic over pull is observed.
- It can be happened while tripping or drilling and it is also related to micro doglegs.
- Circulation can be established without any restriction.
- **FIRST ACTION:**
- If the drillstring is stuck while moving up, jar down with maximum trip load. Torque can be applied with caution while jarring down.
- If the drillstring is stuck while moving down, jar up with maximum trip load without applying any torque in drill string.
- If the drill string is free, you may need to consider back reaming to clear some ledges
- **Preventive actions:**
- Minimize big stabilizers.
- Minimize changes in inclination and azimuth.
- Back reaming operation should be performed when the suspected formations are drilled. Carefully watch the over pull while reaming.
- Slow down tripping sleep when entering possible problematic formations

E-MOBILE FORMATION

CAUSES:

over burden weight squeezes plastic salt or shale into the wellbore

the BHA becomes jammed in the under gauge hole

Warning :

prognosed salt or plastic shale

sudden increase in over pull or set down weight

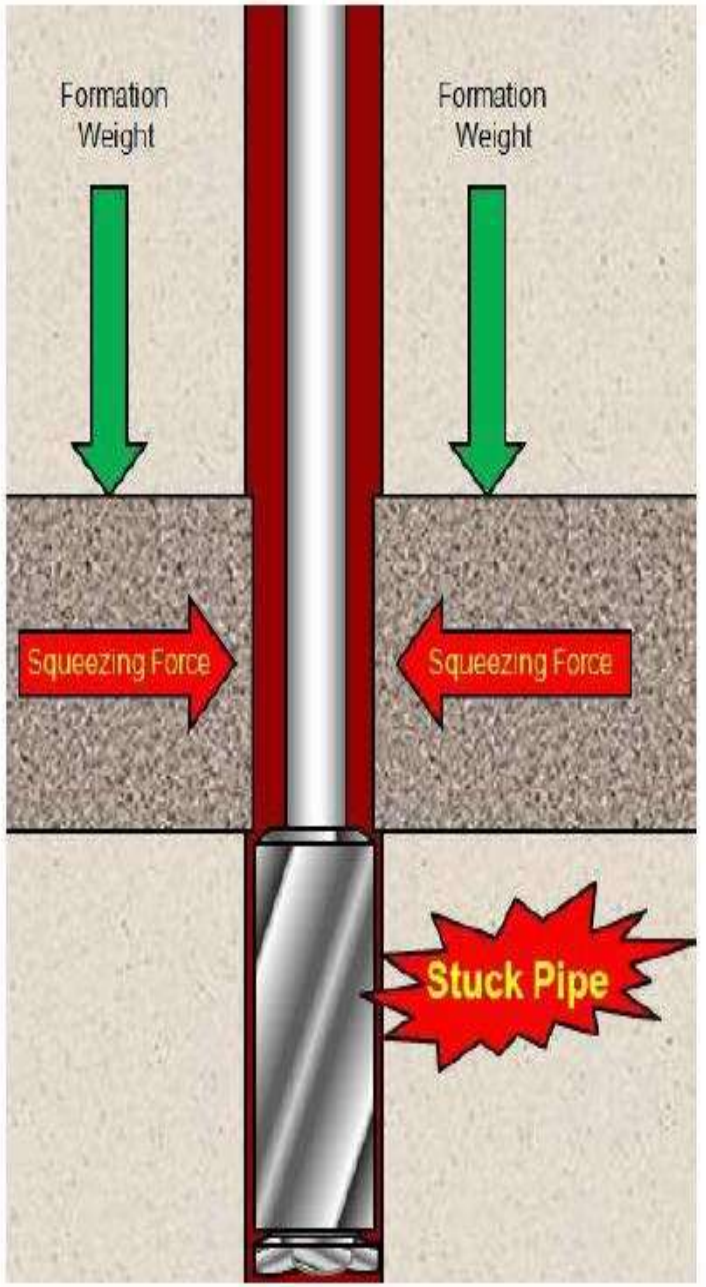
sudden torque increase with fast moving plastic formation

INDICATIONS:

generally occurs while POOH possible when RIH after a long period out of the hole

possible while drilling if formation moves fast sticking occurs with BHA at plastic zone depth

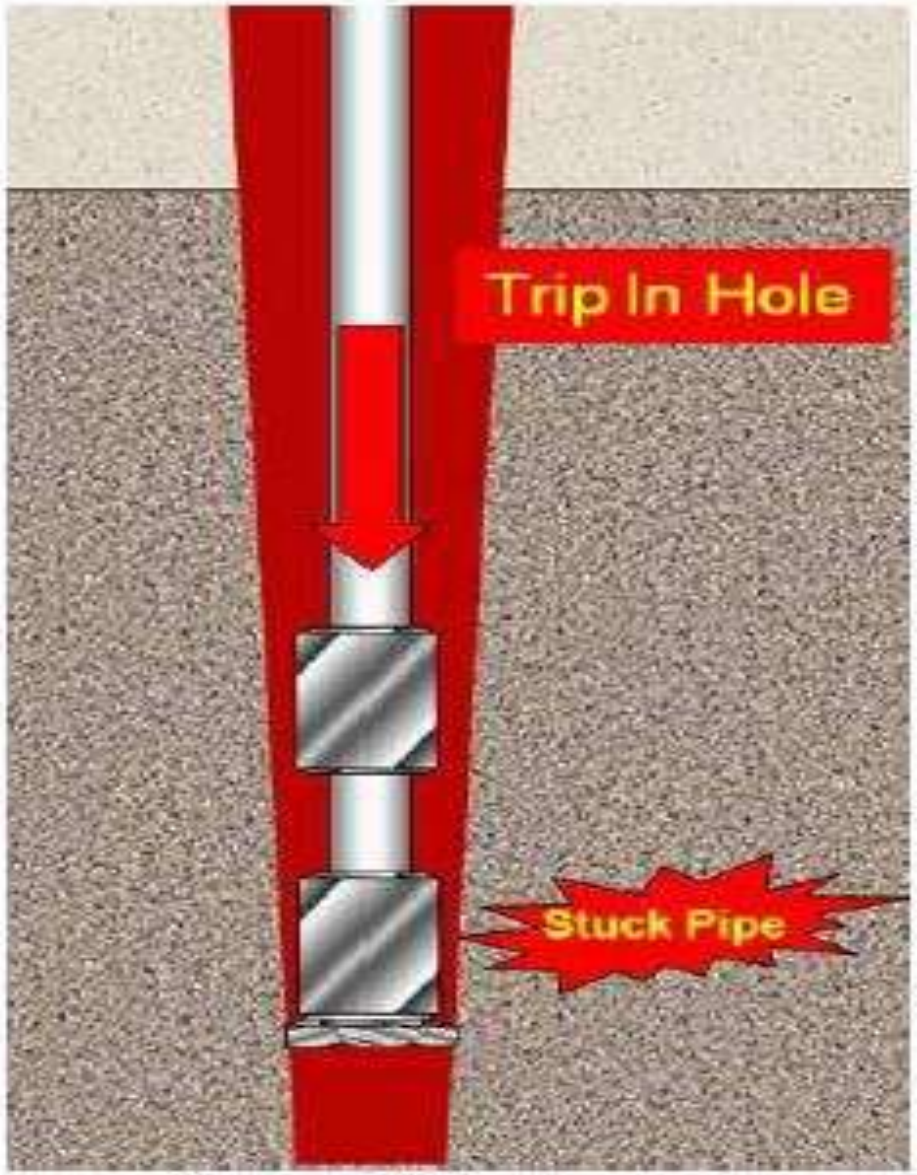
circulation unrestricted or slight restriction possible



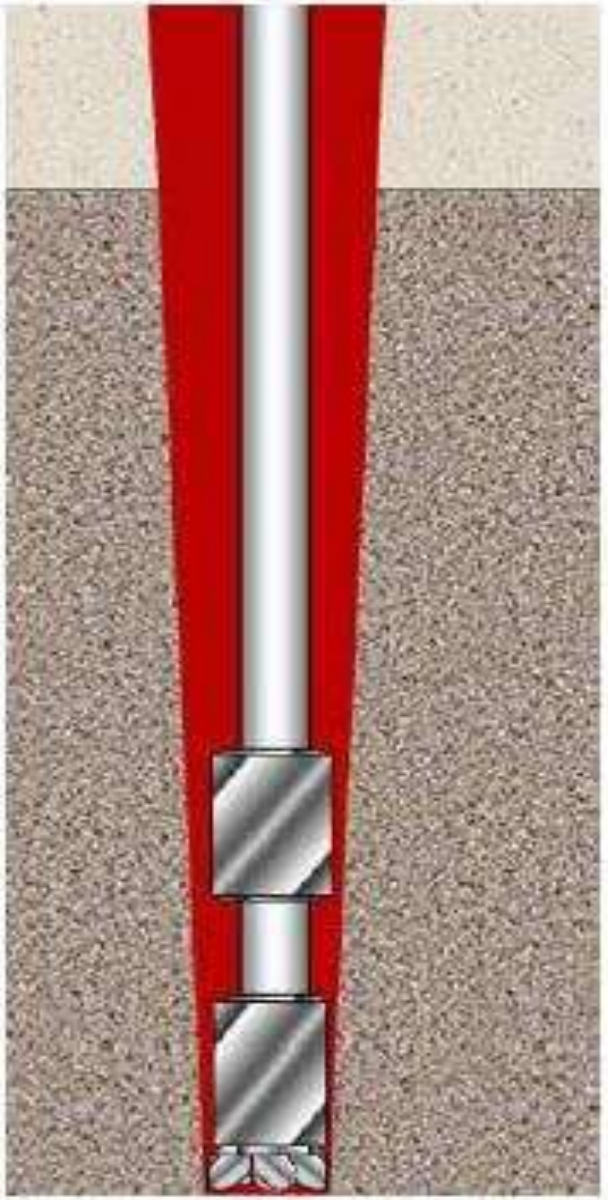
- **FIRST ACTION:**
- if moving up, apply torque and jar down with maximum trip load
- if moving down, jar up with maximum trip load. do not apply torque
- spot fresh water if in salt. (consider well control)
- **PREVENTIVE ACTION:**
- select the correct mud system
- maintain sufficient mud weight
- plan frequent reaming/ wiper trips
- consider eccentric PDC bits
- slow trip speed before BHA enters suspected zone
- minimize open hole exposure time

F- Under gauge Hole

- **CAUSES** :Under gauge hole can be happened when drilling in to hard and abrasive formations where wears a drill bit. When the bit is under gauge because the abrasive formation wears a bit and stabilizers, a hole size becomes smaller. When the new BHA is run in hole, the new bit/BHA gets stuck into the under gauge hole section. Additionally, if coring operation is performed with smaller core bit than the next bit, the new bit can get stuck at the top of coring section.



The next BHA gets stuck.



Hole becomes smaller due to bit and stabilizers worn out

- WARNING:
- when PDC bit follows roller cone bit run
- running in hole after coring
- Drilling into abrasive formations.
- A bit and stabilizers are under gauge.
- **INDICATIONS:**
- occurs only when RIH
- sudden set down weight
- bit stuck near bottom or at top of core hole section
- circulation unrestricted or slightly restricted

- **FIRST ACTION:**
- This stuck pipe is always happen while the drillstring is being moved down; therefore you need to jar up with maximum trip load without applying any torque in drill string.

- **Preventive actions:**
- gauge pulled bit and stabilizers
- never force bit through tight spots
- ream the last 3 joints to bottom
- begin reaming 3 joints above core hole section
- slow trip speed before BHA enters suspected zone

STUCK PIPE WORK SHEET

Recommended instructions for Stuck-Pipe Prevention;

- Bottom hole Assembly:
  - Operate BHA and string within limits
  - Keep the BHA as simple as possible
  - Run a drilling jar whenever possible
  - Whenever possible use spiral drill collars
  - Stabilize the BHA to minimize wall contact
  - Always gauge bits and stabilizers accurately

In Conclusion

Stuck pipe is not inevitable;

- Communicate effectively
- Plan Ahead
- Listen to the hole constantly
- Maintain good mud
- Keep the pipe moving
- Clean out the hole as fast as you can drill it
- Take action early

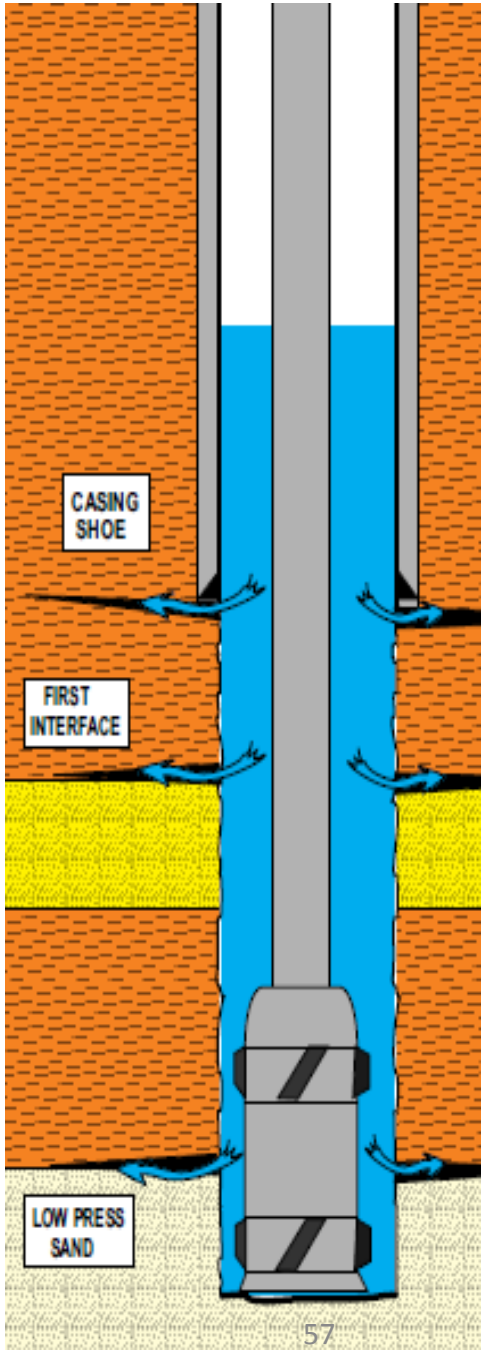
- ***B- LOST CIRCULATION***

- Measurable loss of whole mud (liquid phase and solid phase) to the formation. Lost circulation can occur at any depth during any operation

LOST CIRCULATION MECHANISMS	
PRESSURE INDUCED FRACTURE	Wellbore pressure exceeds fracture pressure of the formation causing the rock to *ra* *open* (fracture)
NATURALLY EXISTING FRACTURES / HIGH PERMEABILITY	Over balanced wellbore pressure is exposed to a formation with unsealed fractures or high permeability

CAUSES OF LOST CIRCULATION	
PRESSURE INDUCED FRACTURES	**NATURAL FRACTURES / PERMEABILITY**
Excessive mud weight	Unconsolidated formation
Annulus friction pressure	Fissures / fractures
Wellbore pressure surges	Unsealed fault boundary
Imposed / trapped pressure	Vugular / cavernous formation
Shut-in pressure	
Low formation pressure	

- **1- PRESSURE INDUCED FRACTURES**
- **CAUSE:**
- wellbore pressure greater than formation fracture pressure
- the formation fractures allowing mud loss
- **WARNING:**
- Prognosed loss zone
- Excessive mud weight
- low fracture strength
- Poor hole cleaning
- Wellbore pressure surges

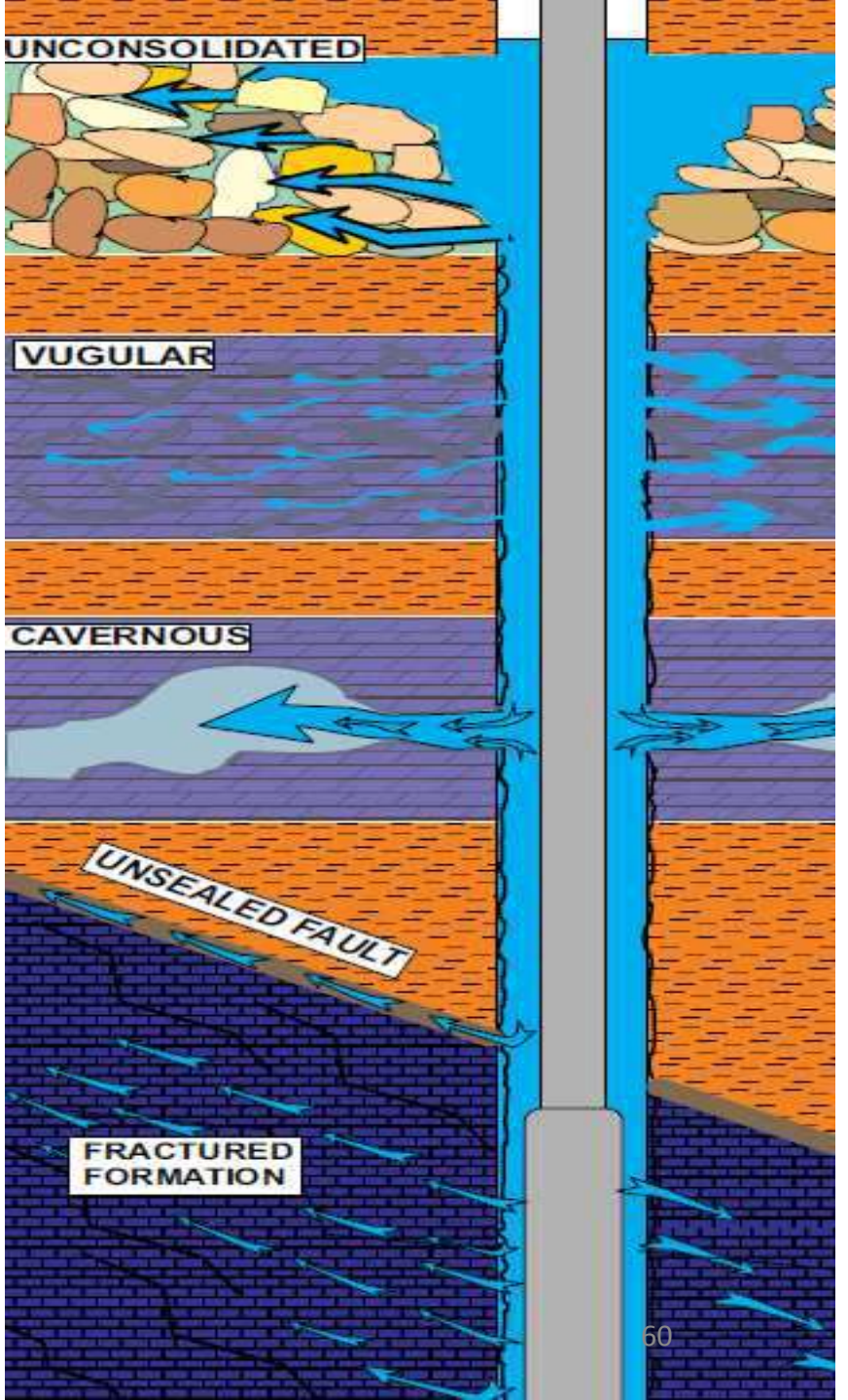


- **INDICATIONS:**
- May begin with seepage loss,
- Possible total loss
- Pit volume loss
- Excessive hole fill-up
- If shut-in, sudden loss of pressure
- **FIRST ACTION (TOTAL LOSS):**
- Reduce pump speed to 1/2
- Pull off bottom, stop pumps zero stroke counter, fill annulus With water or light mud
- Record strokes if / when the annulus fills up
- Monitor well for flow

- **PREVENTIVE ACTION:**
- Minimize mud weight/maximize solids removal
- Control penetration rate
- Minimize wellbore pressure surges
- Avoid imposed / trapped pressure

NATURAL FRACTURES / HIGH PERMEABILITY

- **CAUSE:**
- wellbore pressure is over balanced to formation pressure
- mud is lost to natural fractures and/or high permeability
- **WARNING:**
- Prognosed loss zone
- lost circulation can occur at any
- Time during any open hole operation



- **INDICATIONS:**
- May begin with seepage loss, total loss possible
- Static losses during connections /survey
- Pit volume loss
- **FIRST ACTION (TOTAL LOSS):**
- Reduce pump speed to 1/2
- Pull drill string off bottom, stop circulation
- Zero stroke counter, fill annulus with water or light mud
- Record strokes if / when the annulus fills up
- Monitor well for flow
- **PREVENTIVE ACTION:**
- Minimize mud weight
- Control penetration rate
- Minimize wellbore pressure surges
- Pre-treat with lcm

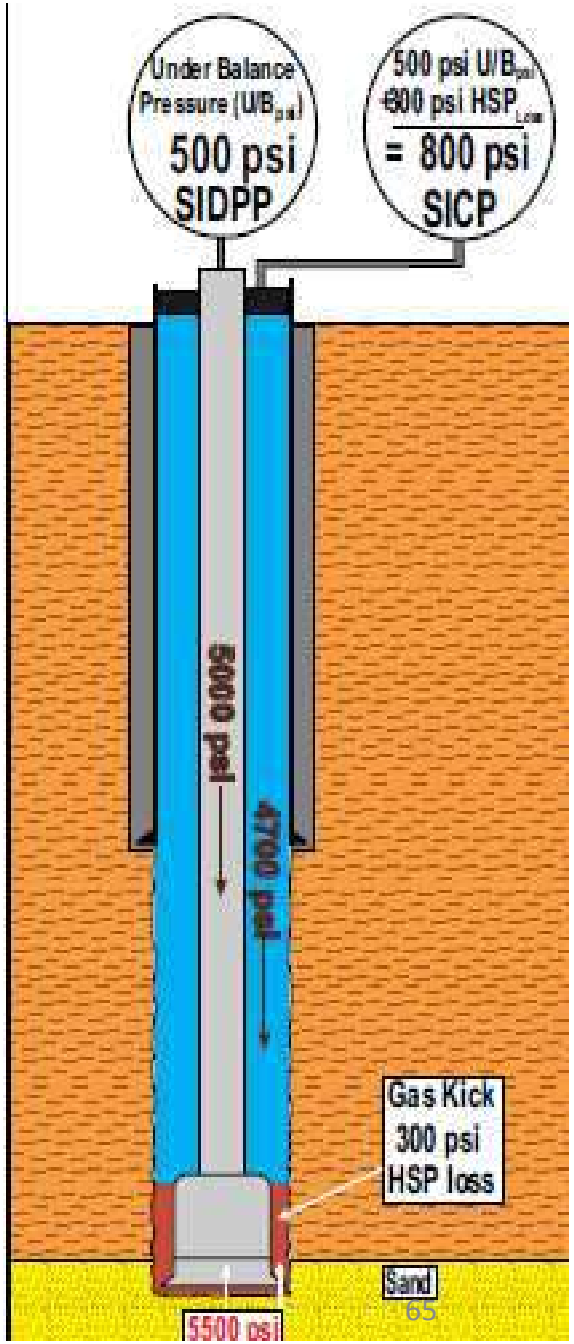
LOSS SEVERITY CLASSIFICATIONS		
SEEPAGE LOSS (< 20 BBLS/HR)	**PARTIAL LOSS (> 20 BBLS/HR)**	**TOTAL LOSS (NO RETURNS)**
GRADUAL LOSSES OPERATION NOT INTERRUPTED POSSIBLE WARNING OF INCREASED LOSS SEVERITY	IMMEDIATE DROP IN FLUID LEVEL WHEN PUMPING IS STOPPED SLOW TO REGAIN RETURNS AFTER STARTING CIRCULATION OPERATIONS USUALLY INTERRUPTED REMEDIAL ACTION REQUIRED	RETURN FLOW STOPS IMMEDIATELY PUMP PRESSURE DECREASE STRING WEIGHT INCREASE OPERATION SUSPENDED REMEDIAL ACTION REQUIRED

GUIDELINES FOR LOST CIRCULATION SOLUTIONS		
ACTION	RESULTS	CONSIDERATIONS
MINIMIZE MUD WT	Reduced Wellbore pressure (the driving force pushing mud into the loss zone)	More successful with pressure induced fractures. Possible well control event or hole instability problems
FORMATIO HEALING TIME	Reactive clays of loss zone swell with water of WBM producing a plugging effect . Soft shales deform with formation stress helping to ' heal ' the fracture	More successful with fresh water mud lost to shale informations Better results with LCM Normal 6 –8 hours wait time with string in casing
LOSS CIRC MATERIAL (LCM)	Effectively bridges, mats and seals small to medium fractures /permeability	Less effective with large fractures, faults Ineffective with cavernous zones Increase LCM lbs / bbl with loss severity
SPECIALTY TECHNIQUES	A plug base is pumped into the loss zone followed by a chemical activator the two materials form a soft plug	Can be used in production zones Increased risk of plugging equipment Plug breaks down with time
CEMENT	Cement slurry is squeezed into the loss zone under injection pressure The slurry cures to solid plug	Provides a ' fit – to – form ' solid plug at or near the stress of the surrounding formation
DRILLING BLIND	In some cases , the only practical solution is to drill without returns	Not a consideration where well control potential exist Set casing in the first competent formation

C- WELL CONTROL

- ***Well kick***: can be define as a well control problem in which the pressure found within the drilled rock is greater than mud hydrostatic pressure acting on the borehole or rock face. when this occurs the grater formation pressure has tendency to force formation fluids into the well bore….this fluid flow is called a kick.
- If the flow is successfully controlled the kick has been killed.
- ***Blowout*** is the result of an uncontrolled kick

- **UNDER BALANCE KICK**
- ***CAUSE:***
- permeable zone is drilled with mud wt insufficient to control formation pressure
- ***WARNING:***
- prognosed abnormal formation pressure
- offset well data
- ***INDICATIONS:***
- geologist / mud logger abnormal pressure trend changes
- torque /drag increase
- drilling break
- well flow /pit gain

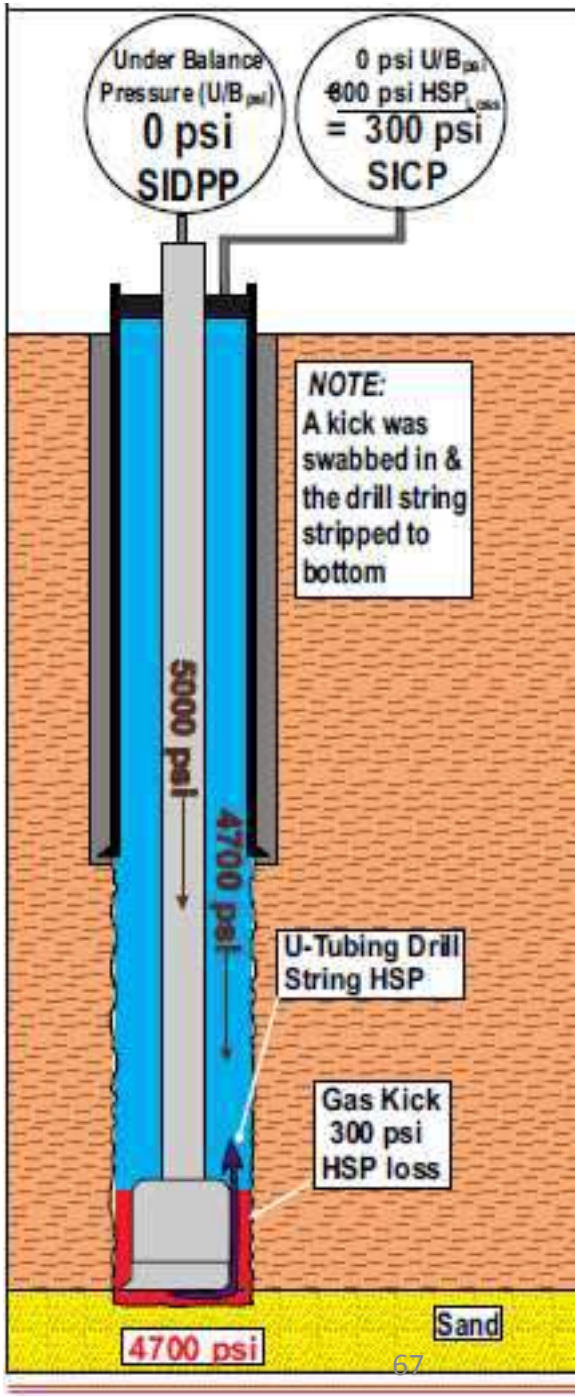


- ***FIRST ACTION:***
- sound kick alarm
- position drill string for shut-in
- stop the pumps /shut-in the well

- ***PREVENTIVE ACTION***
- adjust mud weight prior to drilling known abnormal pressured zone
- observe abnormal pressure warning signs

- **INDUCED KICK**
- Kick caused by a decrease in hydrostatic pressure below formation pressure of a permeable zone.
- CAUSE:
- hydrostatic pressure is reduced below the formation pressure of a permeable zone (swabbing, lost circulation, light mud)

- WARNING:
- Prognosed loss circulation potential
- High mud weights increase potential for swabbing



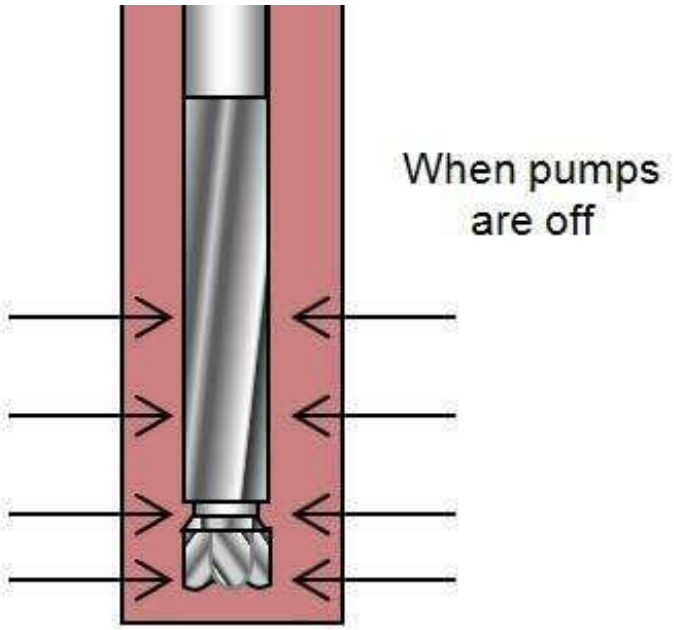
- INDICATIONS:
- loss of circulation during any operation
- Hole not taking correct fill-up during trip
- Water/gas-cut mud while circulating
- Well flowing, pit gain
- FIRST ACTION
- Sound kick alarm
- Position drill string for shut-in, stop circulation shut-in the well
- If off bottom, maintain string movement when possible
- **PREVENTIVE ACTION:**
- Maintain proper mud weight keep hole full
- Proper hole fill-up on trips
- Minimize lost circulation potential

Well ballooning

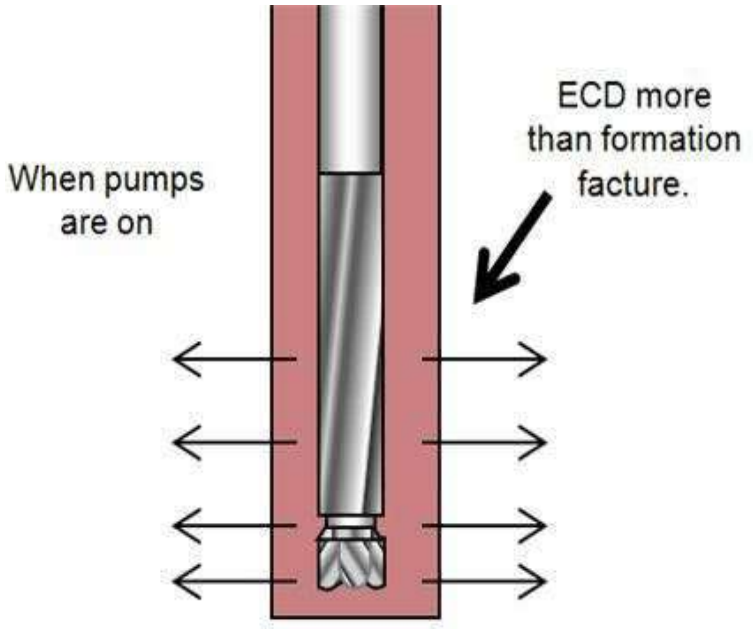
- The well ballooning effect is a natural phenomenon occurring when formations take drilling mud when the pumps are on and the formations give the mud back when the pumps are off.
- **Mechanism of well ballooning**

- While pumps are on, if Equivalent Circulating Density (ECD) exceeds formation fracture, micro fractures are created and drilling mud will lose into small induced formation fractures. The micro fractures can be propagated and it may cause a lot of mud volume losses down hole. Micro fracture will not cause severe losses or totally losses. When pumps are off, the ECD will reduce because annular pressure loss becomes zero. The induced micro fractures will close and the drilling mud will flow back into a wellbore

- The ballooning can happen into any weak formations, not only at the casing shoe. Sometimes, mud flow back from formations can bring gas or formation water with the mud therefore you may see gas peak or mud contaminated with water while circulating bottom up.



Mud flow back because micro fractures are closed.



Mud lose into small induced formation fractures.

How to identify well ballooning

- Drilling mud losses – you must have mud loss into formation in order to have mud flow back when pumps off.
- Flow back when pump off and flow rate decrease over time

you must line the well up into a trip tank and monitor well. Tracking volume flow back every minutes help you understand if flow back trend decreases. The key thing is “flow back rate must reduce over time”. If not, you will have well control situation instead. Monitoring well takes time and personnel must be patient.

• The more mud you lose, the faster flow back is and the longer time will take before the well is static (flow completely stop).

• Mud flow back from formations can bring gas or reservoir water with the mud therefore you may see gas peak or mud contaminated with formation water at the same depth while circulating bottom up.

- **There are important rules that you should know about well ballooning as listed below.**
- Treat the well as kick until you are 100% sure that the ballooning occurs.
- Mud loss into formations must be happened first before you can have flow back. If you have flow back but you don't lose any mud, this is not ballooning.
- In a ballooning well, flow back rate will decrease over time but in a well control well, flow back rate will increase over time.
- Drilling mud losses – you must have mud loss into formation in order to have mud flow back when pumps off.
- Flow back when pump off and flow rate decrease over time

- **How to prevent well ballooning**
- **Manage Equivalent Circulating Density (ECD)**
- • Develop pumping schedule to minimize ECD and still have good hole cleaning
- • Select proper BHA and drill size – this directly affects annular pressure loss.
- • Drilling mud properties – do not have high rheology mud while drilling. Moreover, good mud cake will seal porous formation and minimize losses down hole. Try to keep mud properties in good shape and treat mud ahead of the time if needed.
- **Good Drilling Practices**
- • Bring pumps up slowly and stage-by-stage increment
- • Don’t try to surge wellbore while tripping in hole, working pipe, etc.
- • Slowly rotate drill string for few seconds to break gel prior to slowly bringing pumps up to speed

Bit problems

- A- Bit balling
  - Bit balling is a condition whereby formation becomes packed between the cones and bit body or between the cutting elements such that the ROP suffers. There may or may not be any evidence of skidding or physical damage to the bit.

Causes:

- 1- **Clay /shale lithology with water based mud .**
- **2-Inadequate hydraulics.**
- **3- High weight on bit**
- **4-Improper bit selection**
- **5- High ROP**
- **6- Mud properties (viscosity).**
- **INDICATIONS:**
- **ROP - less than expected in soft rock. 5-10 m/hr may still be possible but will decrease with time**
- **Torque – less than expected and may show decrease with time**
- **Standpipe pressure – increase by 100-200 psi with a PDC bit with no associated increase in flow. Pressure increase may disappear when bit is pulled off bottom**

- Action take :

- Reduce WOB on ROP drop, pick bit up off bottom as quickly as possible •

  Increase flow rate if possible

  • Spin bit off bottom with high RPM and high flow for 5 minutes

- Return to drilling with very low weight

  • Prepare to pump sweeps

- Lift and drop the string rapidly to ‘shake’ the formation off, (take care not to surge the hole and damage the formation or drop the bit on bottom and damage the cutting structure).

- Prepare to trip if these actions are not successful and chose more

  optimum, bit, hydraulics nozzling arrangement or mud system.

Bit nozzle lost

This characteristic describes a bit that is missing one of more jet nozzles

Causes:

Improper nozzle installation

Mechanical damage to nozzle

Wrong nozzle type for application

Erosion damage to nozzle Bit balling

INDICATIONS:

1- sudden decrease in ROP

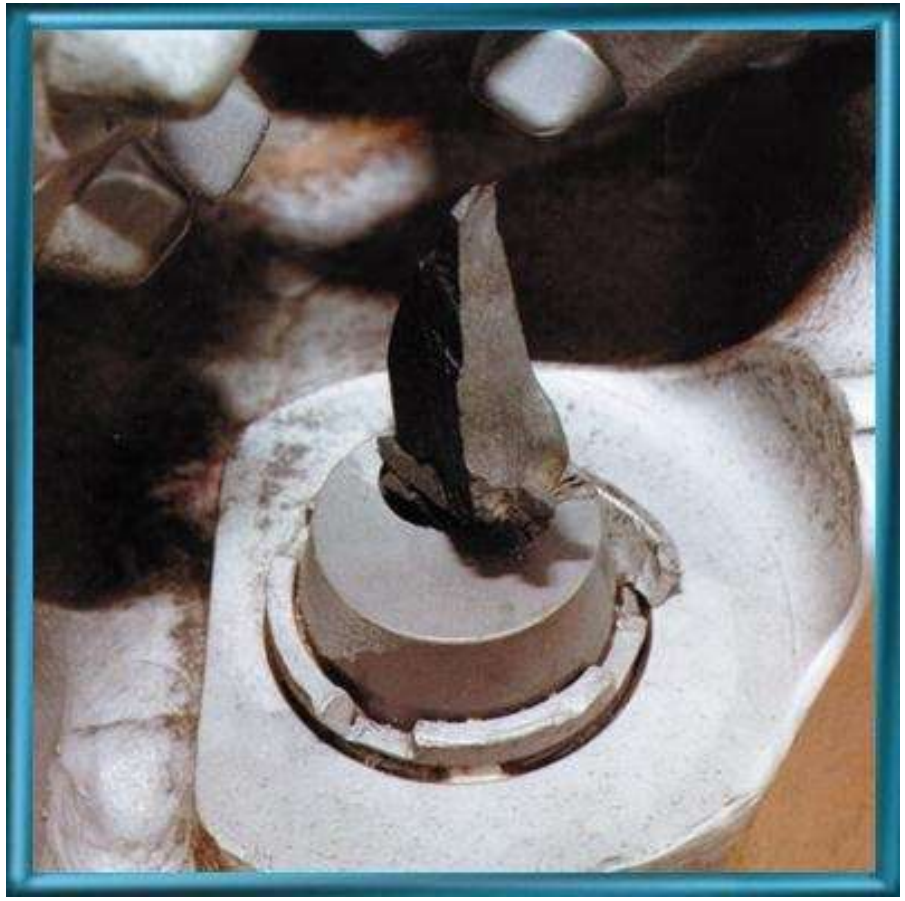
2- sudden reduction stand pipe pressure

ACTION TAKE:

POOH change nozzle

Plugged Nozzle

- A characteristic where one or more of the nozzles are obstructed



Causes:

Improper drilling practices

Pumped foreign material (LCM)

Formation plugging

- **INDICATIONS:**
- A plugged nozzle will result in increased SPP.
- • If penetration rate is not significantly reduced drilling can continue.
- • If multiple nozzles are plugged and there is a severe deterioration in RoP it should be attempted to un-plug the nozzles or pull the bit out of hole.
- **ACTION TAKE:**
- Increase flow rate to the maximum for at least 5mins.
- o Lift and drop the string to ‘shake and surge’ the plugging material free, (take care not to surge the
- hole and damage the formation or drop the bit on bottom and damage the cutting structure).
- • A bit with plugged nozzles has an increased probability of balling in softer formations and accelerating cutter wear in abrasive formations.

Washed Out Bit

- A washout is where drilling fluid has eroded a passage from an internal flow area to the exterior of the bit. It is not limited to welds

CAUSES:

- **Excessive impact load / Improper drilling practices**
- **Improper nozzle installation**
- **Mechanical damage to nozzle**
- **Wrong nozzle type for application**
- **Erosion damage to nozzle**
- **Bit balling**
- **INDICATIONS:**
- **1- sudden decrease in ROP**
- **2- sudden reduction stand pipe pressure**
- **3- reduction in reactive torque at rotary table**
- **Action take:**
- **POOH change the bit**

Drilling on junk

- A condition where the bit has indentations caused by contact with objects other than formation
- **CAUSE:**
- **Junk inside hole (bit nozzle,hammer,dice.chain..)**

INDICATIONS:

Decrease in ROP

Variation in reactive torque

Action take :

POOH and check

Pipe twist off

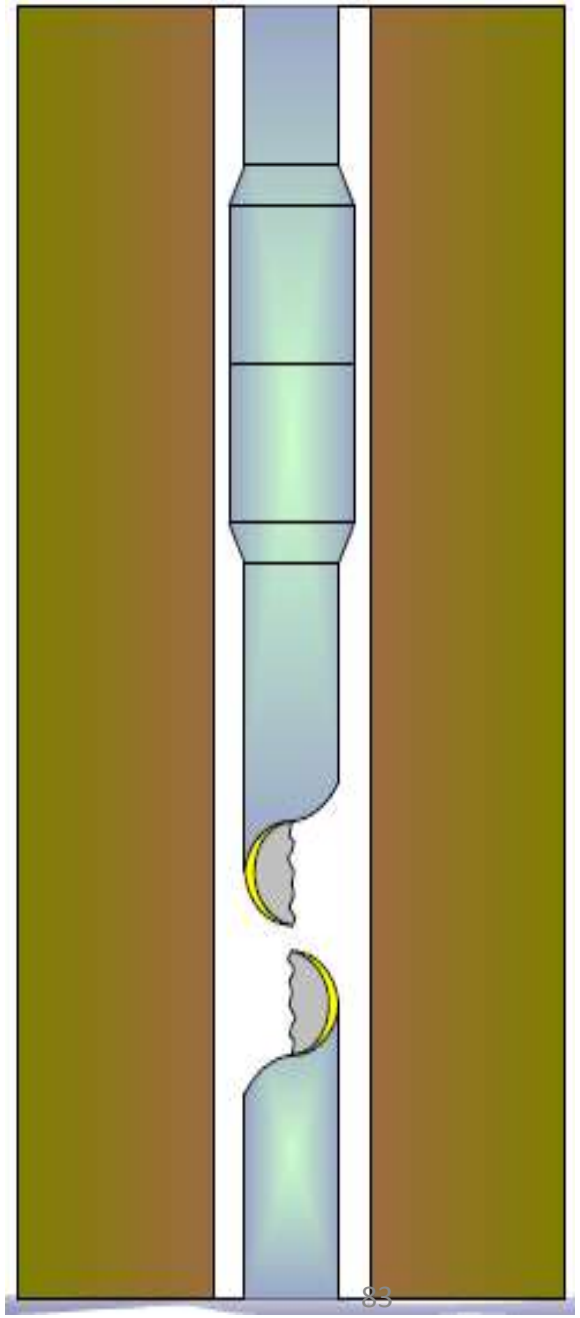
Parting or breaking of the drillstring downhole due to fatigue or excessive torque

CAUSES :

rough pipe handling,
faulty drill string,
stress reversals in a sharply
deviated hole drilling with drill pipe in compression,
poorly stabilized drill collars
scarring by tong dies,
improper makeup torque,
erosion caused by washout, and other damage that create weak
spots where cracks can form and enlarge under the constant bending
and torque stresses of routine drilling

INDICATORS:

loss of drill string weight,
lack of penetration,
reduced pump pressure,
increased pump speed,
reduced drilling torque, and increased rotary speed



Drill String Washouts

- A *drill string washout* is any hole or crack in the drill string caused by corrosion, fatigue or failure of the drill string.

- **CAUSES**
- Poor equipment handling
- Deviated holes and doglegs
- Running drill pipe in compression
- Incorrect make-up torque of tool joints
- Corrosive mud or gases
- Vibrations or slip/stick conditions
- Erratic torque
- High loads, jarring
- INDICATORS
- pressure **gradually** dropped same pumping rate
- If left unattended, the pressure drop will accelerate as the washout becomes more severe

- Action take

- When we observed pressure loss, we **stopped rotating**, just only circulating, and figured out where the washout was.

- **check surface equipment:** Closed IBOP, pressure up surface equipment with mud pump to 3000 psi and held for 5 mins. Everything was OK, no pressure loss. Therefore, there was nothing wrong with surface line and It should be down hole.

Rig equipment problems

- **Pump failed (power failed,**
- **B.O.P malfunction(actuator failure , leak)**
- **Hoisting malfunction**
- **Rotary table/ TDS malfunction**
- **Gage malfunction**
- **Choke malfunction (washout ,plug, seized)**