QUESTION ???

List out the different Borehole Problems that will Encounter during Drilling, Tripping and during production.

Borehole Problems

It is almost certain that problems will occur while drilling a well, even in very carefully planned wells. For example, in areas in which similar drilling practices are used, hole problems may have been reported where no such problems existed previously because formations are nonhomogeneous. Therefore, two wells near each other may have totally different geological conditions.

Types of Borehole problems

In well planning, the key to achieving objectives successfully is to design drilling programs on the basis of anticipation of potential hole problems rather than on caution and containment. Drilling problems can be very costly. The most prevalent drilling problems include:

- Pipe sticking
- Loss of circulation
- Hole deviation
- Pipe failures
- Borehole instability
- Mud contamination
- Formation damage
- Hole cleaning
- Equipment and personnel-related problems

Pipe Sticking

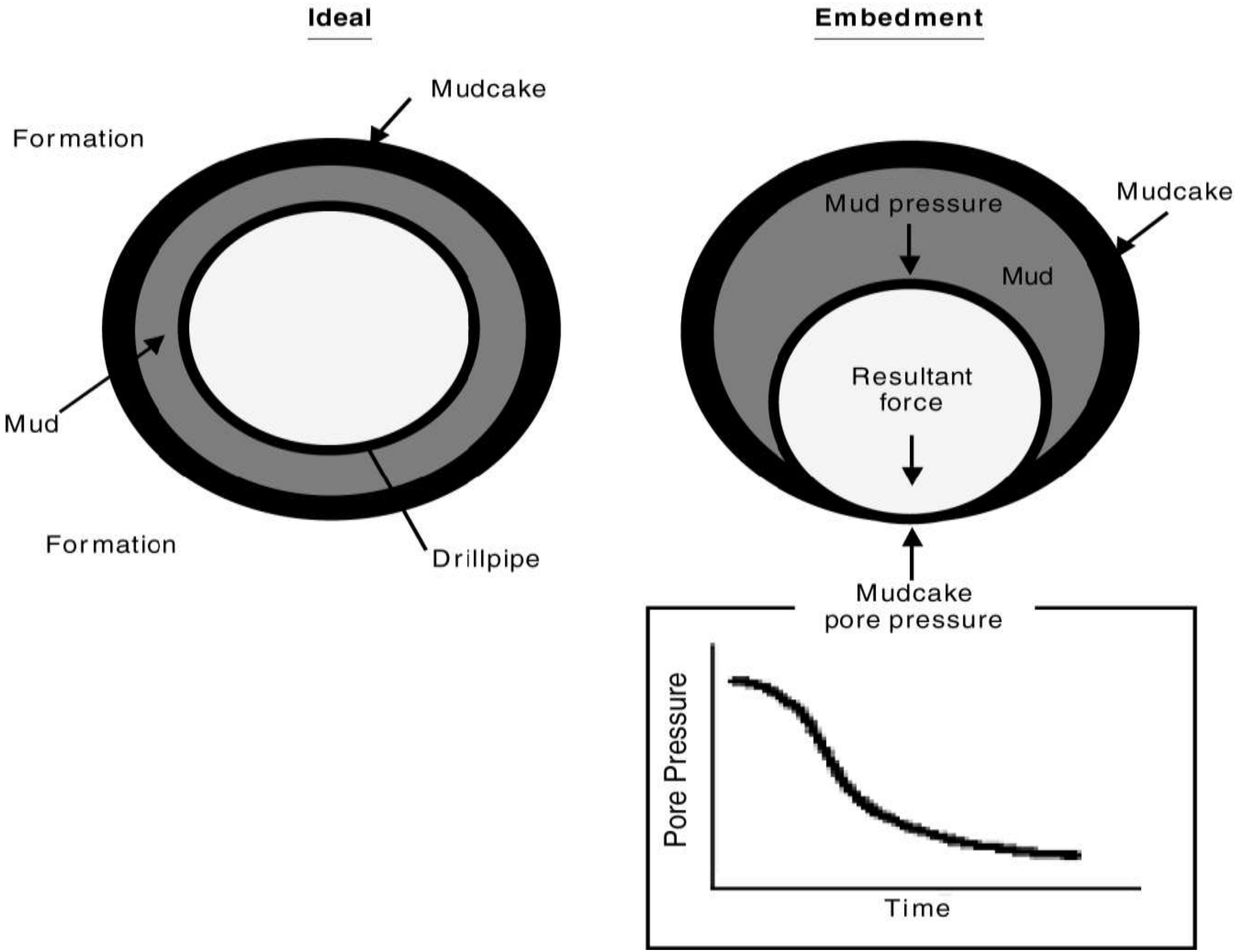
- During drilling operations, a pipe is considered stuck if it cannot be freed from the hole without damaging the pipe, and without exceeding the drilling rig's maximum allowed hook load. Pipe sticking can be classified under two categories:

1. Differential pressure pipe sticking
2. Mechanical pipe sticking

Causes and prevention of stuck pipe

- Complications related to stuck pipe can account for nearly half of total well cost, making stuck pipe one of the most expensive problems that can occur during a drilling operation.[Stuck pipe often is associated with well-control and lost-circulation events—the two other costly disruptions to drilling operations—and is a significant risk in high-angle and horizontal wells.

- Drilling through depleted zones, where the pressure in the annulus exceeds that in the formation, might cause the drillstring to be pulled against the wall and embedded in the filter cake deposited there. The internal cake pressure decreases at the point where the drillpipe contacts the filter cake, causing the pipe to be held against the wall by differential pressure. In high-angle and horizontal wells, gravitational force contributes to extended contact between the drillstring and the formation. Properly managing the lubricity of the drilling fluid and the quality of the filter cake across the permeable formation can help reduce occurrences of stuck pipe.


Ideal
Embedment
Mudcake
Formation
Mud
Formation
Drillpipe
Mud pressure
Mudcake
Mud
Resultant force
Mudcake pore pressure
Pore Pressure
Time

Mechanical causes for stuck pipe include:

- Keyseating
- Packoff from poor Holecleaning
- Shale swelling
- Wellbore collapse
- Plastic-flowing formation (i.e., salt)
- Bridging

Preventing stuck pipe can require close monitoring of early warning signs, such as:

- Increases in torque and drag
- Excessive cuttings loading
- Tight spots while tripping
- Loss of Circulation during drilling

LC - Lost Circulation

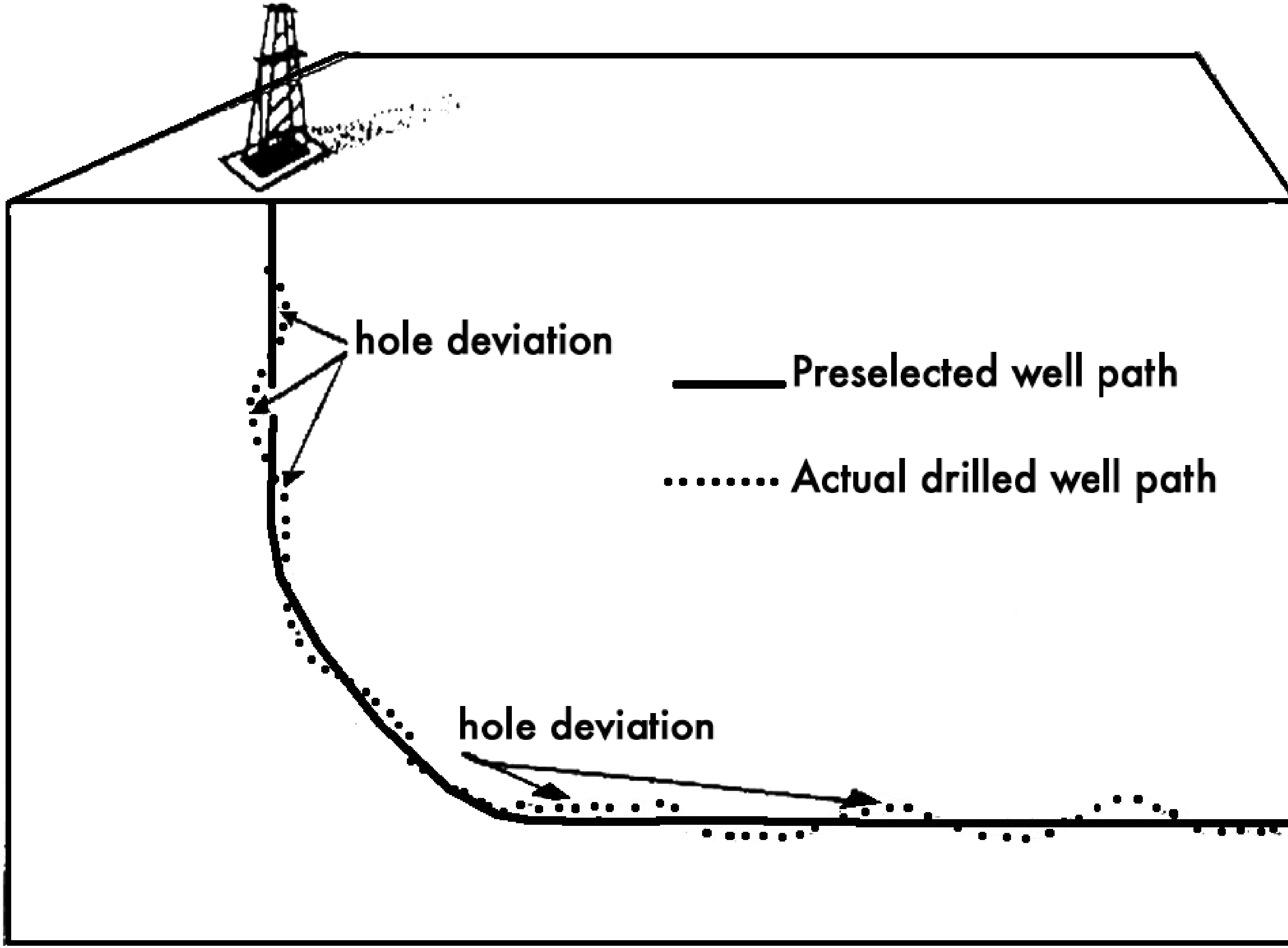
- Occurs in two ways:
  - In zones with large diameter pores or channels (vuggy carbonates, rubble zones, fractured zones, fault zones…)
  - In conditions where $p_w > \sigma_{hmin}$ and a hydraulic fracture propagates beyond the borehole region
- Pressure controlled drilling helps avoid LC/BO
- “Strengthening” the borehole wall…
  - Increasing the stress around the borehole wall
  - Plugging initiating fractures with solids…

Hole deviation

Hole deviation is the unintentional departure of the drill bit from a preselected borehole trajectory. Whether it involves drilling a straight or curved-hole section, the tendency of the bit to walk away from the desired path can lead to drilling problems such as higher drilling costs.

Causes of hole deviation:

- Heterogeneous nature of formation and dip angle
- Drillstring characteristics, specifically the bottomhole assembly (BHA) makeup
- Stabilizers (location, number, and clearances)
- Applied weight on bit (WOB)
- Hole-inclination angle from vertical
- Drill-bit type and its basic mechanical design
- Hydraulics at the bit
- Improper hole cleaning



hole deviation
Preselected well path
Actual drilled well path
hole deviation

Drillpipe failures

- Drillpipe failures is a prevalent drilling problem. It can be put into one of the following categories: twistoff caused by excessive torque; parting because of excessive tension; burst or collapse because of excessive internal pressure or external pressure, respectively; or fatigue as a result of mechanical cyclic loads with or without corrosion.

- **Twistoff**

Pipe failure as a result of twistoff occurs when the induced shearing stress caused by high torque exceeds the pipe-material ultimate shear stress. In vertical-well drilling, excessive torques are not generally encountered under normal drilling practices.

- **Parting**

Pipe-parting failure occurs when the induced tensile stress exceeds the pipe-material ultimate tensile stress. This condition may arise when pipe sticking occurs and an overpull is applied in addition to the effective weight of suspended pipe in the hole above the stuck point.

- **Collapse and burst**

Pipe failure as a result of collapse or burst is rare; however, under extreme conditions of high mud weight and complete loss of circulation, pipe burst may occur.

- **Fatigue**

Fatigue is a dynamic phenomenon that may be defined as the initiation of microcracks and their propagation into macrocracks as a result of repeated applications of stresses. Drillstring fatigue failure is the most common and costly type of failure in oil/gas and geothermal drilling operations.

Pipe-failure prevention

Although pipe failure cannot be eliminated totally, there are certain measures that can be taken to minimize it. **Fatigue failures** can be mitigated by minimizing induced cyclic stresses and insuring a noncorrosive environment during the drilling operations. Cyclic stresses can be minimized by controlling dogleg severity and drillstring vibrations. Corrosion can be mitigated by corrosive scavengers and controlling the mud pH in the presence of H_2S. The proper handling and inspection of the drillstring on a routine basis are the best measures to prevent failures.

Borehole instability

Borehole instability is the undesirable condition of an openhole interval that does not maintain its gauge size and shape and/or its structural integrity.

Causes

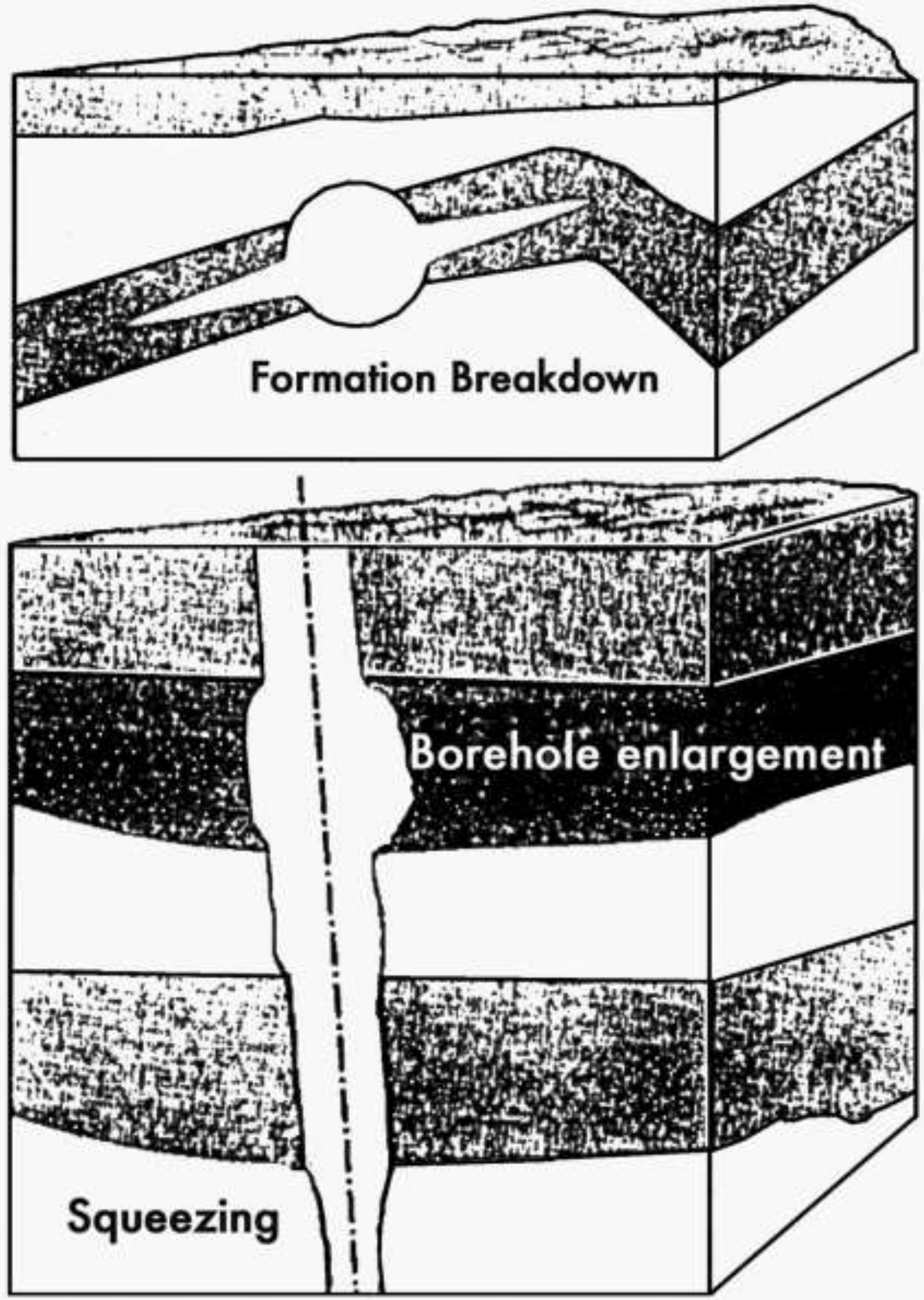
The causes can be grouped into the following categories:

- Mechanical failure caused by in-situ stresses
- Erosion caused by fluid circulation
- Chemical caused by interaction of borehole fluid with the formation

Types and associated problems

There are four different types of borehole instabilities:

- Hole closure or narrowing
- Hole enlargement or washouts
- Fracturing
- Collapse



Formation Breakdown
Borehole enlargement
Squeezing

Shale Instabilty

- Continued sloughing and hole enlargement
  - Hole cleaning difficulties, hole fill on trips
  - Mud rings and blockages
  - Swabbing pressures on trips to change the bit
  - Difficulty in controlling drilling mud properties
- Sudden collapse (usually when $p_o > p_{mud}$)
- Instability in shale also increases the risk of blowouts and lost circulation
- Increased torque, overpull on trips.

Borehole-instability prevention

Total prevention of borehole instability is unrealistic, because restoring the physical and chemical in-situ conditions of the rock is impossible. The preventions include:

- Proper mud-weight selection and maintenance
- Use of proper hydraulics to control the equivalent circulating density (ECD)
- Proper hole-trajectory selection
- Use of borehole fluid compatible with the formation being drilled
- Additional field practices that should be followed are:
- Minimizing time spent in open hole
- Using offset-well data (use of the learning curve)
- Monitoring trend changes (torque, circulating pressure, drag, fill-in during tripping)
- Collaborating and sharing information

Mud contamination

A mud is said to be contaminated when a foreign material enters the mud system and causes undesirable changes in mud properties, such as density, viscosity, and filtration. Generally, water-based mud systems are the most susceptible to contamination. Mud contamination can result from overtreatment of the mud system with additives or from material entering the mud during drilling.

Common contaminants

The most common contaminants to water-based mud systems are:

- Solids (added, drilled, active, inert)
- Gypsum/anhydrite (Ca++)
- Cement/lime (Ca++)
- Makeup water (Ca++, Mg++)
- Soluble bicarbonates and carbonates (HCO_3^-, CO_3^{--})
- Soluble sulfides (HS^-, S^{--})
- Salt/salt water flow (Na+

Formation damage

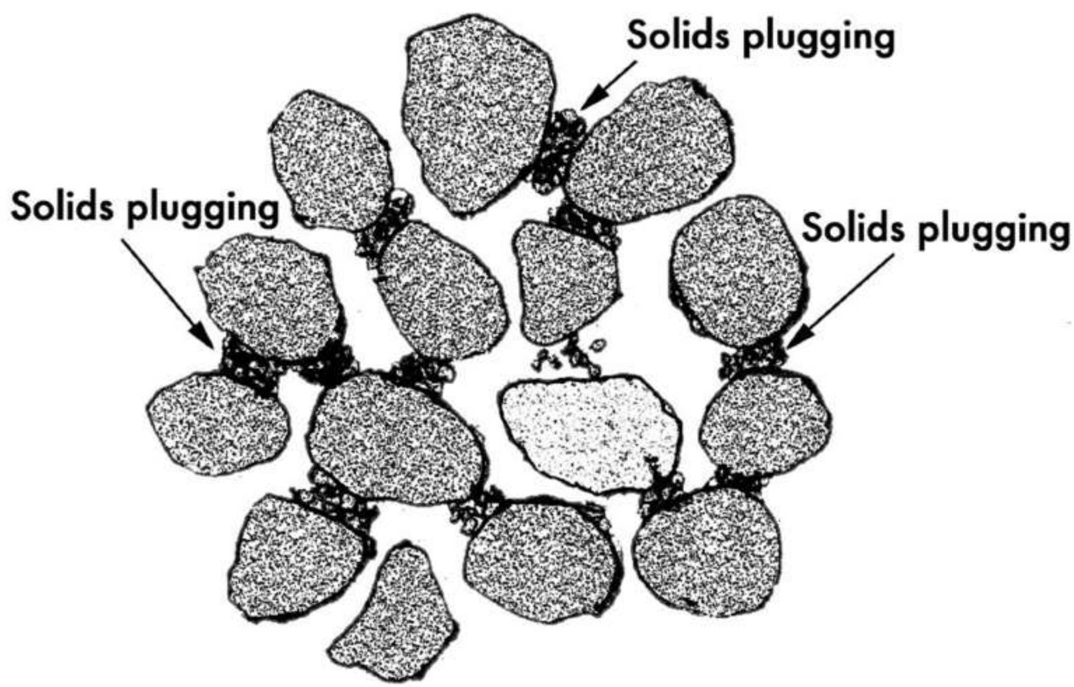
Producing formation damage has been defined as the impairment of the unseen by the inevitable, causing an unknown reduction in the unquantifiable. In a different context, formation damage is defined as the impairment to reservoir (reduced production) caused by wellbore fluids used during drilling/completion and workover operations. It is a zone of reduced permeability within the vicinity of the wellbore (skin) as a result of foreign-fluid invasion into the reservoir rock.

Primary Reasons for formation damage :-

- Ability to recover fluids from the reservoir is affected very strongly by the hydrocarbon permeability in the near-wellbore region
- Although we do not have the ability to control reservoir rock properties and fluid properties, we have some degree of control over drilling, completion, and production operations

Solids plugging :-

The plugging of the reservoir-rock pore spaces can be caused by the fine solids in the mud filtrate or solids dislodged by the filtrate within the rock matrix. To minimize this form of damage, minimize the amount of fine solids in the mud system and fluid loss.



Minimizing of Formation damage

Thus, we can make operational changes, minimize the extent of formation damage induced in and around the wellbore and have a substantial impact on hydrocarbon production. Being aware of the formation damage implications of various drilling, completion, and production operations can help in substantially reducing formation damage and enhancing the ability of the well to produce fluids.

Hole cleaning

Hole cleaning is the ability of a drilling fluid to transport and suspend drilled cuttings. Inadequate hole cleaning can lead to costly drilling problems, such as:

- Mechanical pipe sticking
- Premature bit wear
- Slow drilling
- Formation fracturing
- Excessive torque and drag on drillstring
- Difficulties in logging and cementing
- Difficulties in casings landing

Equipment related drilling problems

Most drilling problems result from unseen forces in the subsurface. But the equipment involved can also be a source of problems. The integrity of drilling equipment and its maintenance are major factors in minimizing drilling problems. The following are all necessary for reducing drilling problems:

- Proper rig hydraulics (pump power) for efficient bottom and annular hole cleaning
- Proper hoisting power for efficient tripping out
- Proper derrick design loads and drilling line tension load to allow safe overpull in case of a sticking problem
- Well-control systems that allow kick control under any kick situation
- Ram preventers
- Annular preventers
- Internal preventers

Understanding and anticipating drilling problems, understanding their causes, and planning solutions are necessary for overall-well-cost control and for successfully reaching the target zone !!!