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Trade Exhibition & Symposium

Applications & Techniques
For
Dual-Tube Reverse Circulation Drilling

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Baroid Industrial Drilling Products

The *Original* Drilling Fluids Company™

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Primary Objective
Geologic Samples

Necessary Processes
&
Potential Problems

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Primary Objective

Acquire a High Quality Sample of Adequate Quantity

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Advantages of Dual-Tube RC

- Good penetration rate & depth capability
- Effective sampling method
  - High quality sample in stable geologic environments
- Potential for acquiring large geologic sample
- Moderately priced option to wire line coring
- Excellent option for:
  - Intermediate exploration
  - Delineation of ore body
  - Grade control

Disadvantages of Dual-Tube RC

- Sample quality can be negatively impacted by highly variable and/or unstable geology
- Characteristics of drilling method itself
  - High pressure/high energy system
- Traditional method offers limited options to counteract problems
- Contributing Factors
  - Ground water/Cascading water
  - Highly fractured geology
  - Borehole instability/erosion
  - Water sensitive formations (clay or shale)

Sample Contamination

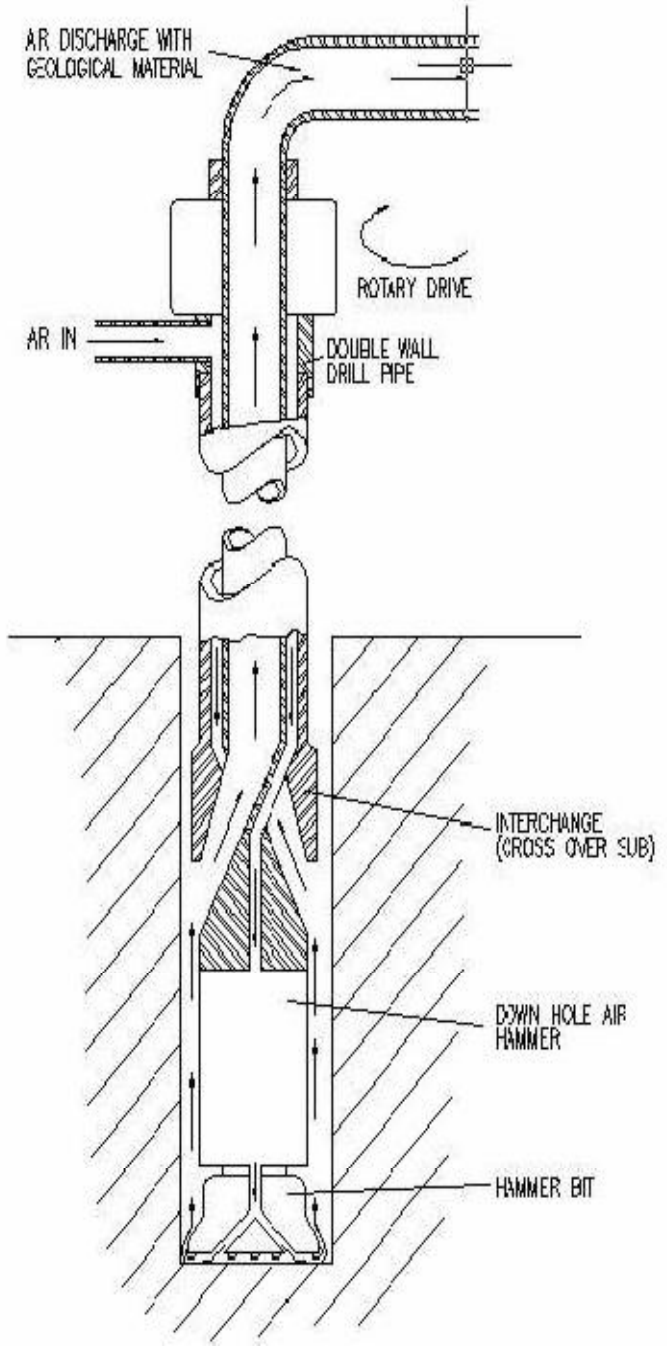
- Well documented problem
  - Cove Deposit – Battle Mountain, Nevada
  - More prominent in gold deposits
- Introduces sampling error (bias)
  - Can create over-estimation of mineral concentration
  - In some cases issue can cause dilution of indicated mineral concentration
  - Sample contamination commonly presents itself as a spike in samples

Contamination Scenario

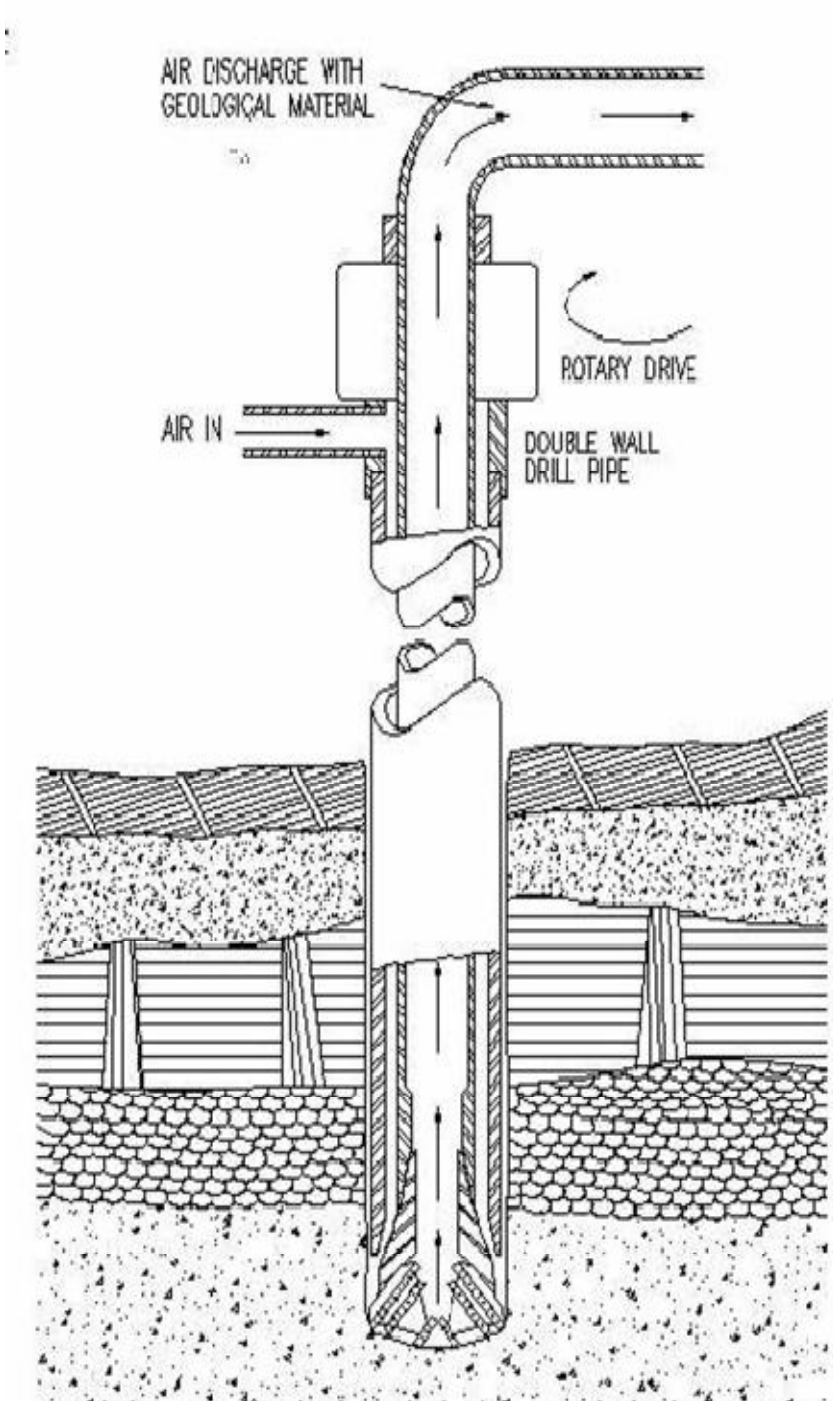
- Gold Exploration, Dual-Tube RC
- 5-foot sampling interval
- 20-ft drill rods, 4 samples per drill rod
- Contractor drills through gold bearing section
- Start of new drill rod
  - 1st, 5-ft sample produces spike of anomalous gold
  - Every fourth sample thereafter produces similar spike
- Direct result of unstable borehole and inability to isolate sampling interval

Proven Tool to Minimize Sample Contamination

Interchange System Conventional Return Bit or Hammer



Center Return Bit or Hammer



Operational Considerations

- Effective performance of Dual-Tube RC depends on borehole geometry
  - Small annular space creates condition where the path of least resistance is up the center tube
- Achieving & maintaining borehole stability is critical
- Isolate sample interval
- Objective is to minimize impact of contributing factors

Drilling Fluid Additives
Dual Tube Reverse

Sample recovery aided by the use of hydrocyclone separator.

Air with additives - injected

- PHPA (Active concentration is critical)
- Foam (Do we need foam or surfactant?)
- De-flocculants (Understand use and impact)
- Inhibitive salts (Inhibition vs. corrosion potential)
- Flocculants - with mechanical separation

Drilling Fluid Additives
Dual Tube Reverse

Closed in Systems:

1) Combines the use of drilling fluid products and mechanical systems to lessen sample contamination on RC holes.
2) Combination of additives may be used on the air injection side to facilitate inhibition of encountered formations and effective separation of geologic sample at the surface.
3) Closed-In-Systems are ideal for Dual Tube RC as it helps keep annulus at low or zero pressure.

Closed-In Systems (continued)

4) Drill string and surface casing are closed in with a non-rotating head to enable drilling fluid products to be pumped down the the slim annular space to stabilize broken zones, to halt or slow the induction of water, and to lessen the chance of sample contamination.

Non-Rotating Control Head

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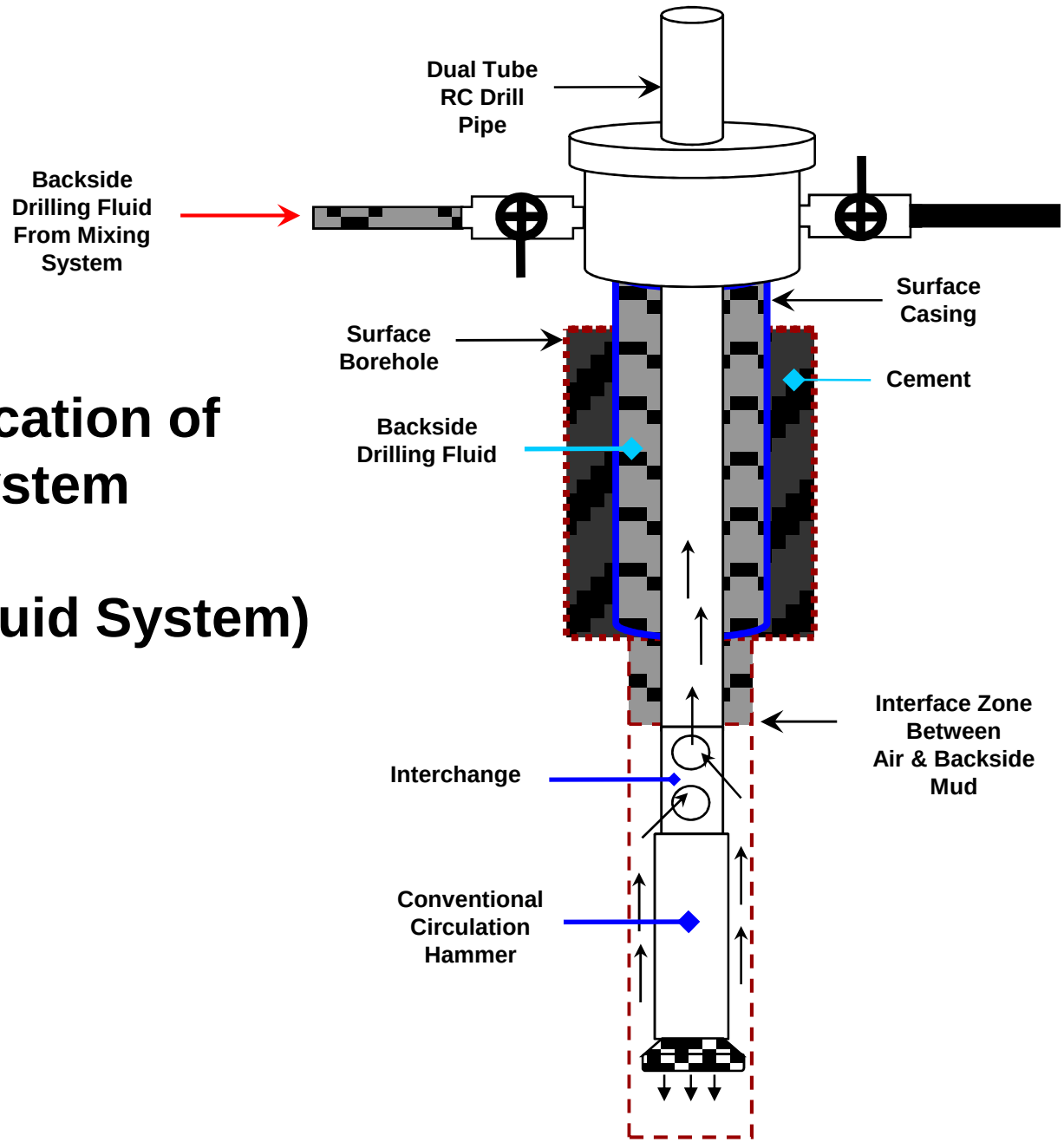
Concept & Application of Closed-In System

(Use of Backside Fluid System)



Mixing Requirements for Backside RC Fluids

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Fluids for Closed-in-Systems

- Typical mixture is not a thin homogeneous mixture…..but more closely resembles oatmeal!!
- Designed for exploration sampling only!!!
- Inverted Order of Addition for mixing
- Per each 250 to 300 gals:
- 1-2 quarts EZ-MUD® PLUS liquid polymer
- 1-2 sks QUIK-GEL®
- 2 sks of Cedar Fiber
- 1 to 1.5 sk Drilling Paper
- 1 to 2 sk N-SEAL™

Fluids for Closed in Systems

- Typical mixture is not a thin homogeneous mixture…..but more closely resembles oatmeal!!
- Designed for exploration sampling only!!!
- Fluid system must be significantly altered for use in non-exploration environments
- Inverted Order of Addition for mixing
- Per 1 m^3:
- 1-2 liters QUIK MUD® liquid polymer
- 1-2 bags QUIK-GEL®
- 1-2 bags of Cellophane
- 1 to 1.5 bags Drilling Paper
- 1 to 2 bags N-SEAL™

Optional Fluid for Closed-in-Systems

1) Soda Ash: 1-2 lb/100 gallons
2) BORE-GEL®: 50 -75 lb/100 gallons
3) N-SEAL™: 30 – 50 lb/100 gallons
4) Drilling Paper: 40 lb/100 gallons
   - Option – In place of Drilling Paper use Shredded Cellophane at 15 – 30 lbs/100 gallons

- The use of BORE-GEL® allows for higher concentrations of bentonite to be added leading to aggressive gel strength development and reduced filtration rate of fluid

Optional Fluid for Closed-in-Systems

1) Soda Ash: 0.5 - 1.0 kg/m^3
2) BORE-GEL®: 60 - 90 kg/m^3
3) N-SEAL™: 35 – 60 kg/m^3
4) Drilling Paper: 40 – 50 kg/m^3
   - Option – In place of Drilling Paper use Shredded Cellophane at 15 – 35 kg/m^3

- Traditional Order of Addition for mixing
- The use of BORE-GEL® allows for higher concentrations of bentonite to be added leading to aggressive gel strength development and reduced filtration rate of fluid

Optional Fluid for Closed-in-Systems

1) Soda Ash: 0.5-1.0 kg/m^3
2) BORE-GEL®: 60 -90 kg/m^3
3) N-SEAL™: 35 – 60 kg/m^3
4) Cellophane: 15 – 30 kg/m^3
5) FUSE-IT®: 1- 1.5 % by volume

- Traditional Order of Addition for mixing
- The use of FUSE-IT® allows for alteration of flow properties while maintaining filtration control and shale/clay stabilization if needed

Fluids for Closed In Systems

The thicker the better!!!!

Resultant slurry viscosity cannot be solely generated from polymers alone

- ***Slurry formulation must match geologic requirements***

1) Lubricates string and reduces rotary torque on vertical and angle holes.
   - Well managed backside fluid can reduce rod wear
   - Minimize potential for differential sticking
2) In holes that encounter ground water at various and/or numerous depths, the mixture prevents or slows downs the amount of water produced while drilling.

Fluids for Closed In Systems

3) Helps cushion annular space from pressure surges and isolates the open pressured area of the hole between the bit and interchange reducing potential for contamination of produced sample.
   - Effective for center return environments as well
4) Allows for less sample contamination as fluid or air movement down annulus to interchange or bit is restricted.
5) Provides mechanism to inhibit water sensitive formations such as clay or shale

Placement Procedures for Backside Mud

- Casing must have effective annular seal
- Non rotating head must be attached to casing with a Victaulic® type coupling. Inside the head are 3 or 4 stripping rubbers that are lubricated by means of a grease fitting.
- Casing attachment and non-rotating head cannot leak
- Two, 2 or 3 inch nipples and ball valves are attached to the casing head below the compressed rubbers.
  - Fluid introduction (fill-up line)
  - Bleed-off

Placement of Backside Mud

- A positive displacement pump to place the fluid is required. (Diaphragm pump is recommended)
- After each connection, the valve is opened and a small amount of the mixture is pumped down the annular space and the air is turned on.
- Whenever a small amount of fibrous material is seen at the separator, pumping is stopped and the valve shut.

Advantages in using Backside Mud

- If started at the beginning of a hole before much broken ground and groundwater are encountered, the annular space more than likely will remain open and not boot off.
- Mixture will exert some hydrostatic head on hole preventing high pressure blow by from charging the annulus and potentially causing additional hole problems.
- The high pressure area of the hole will remain near the bit and the interchange focusing sample return towards the path of least resistance in the center tube.
- There is less chance of losing air return.

Points To Remember

- Fluid system is versatile and should be adjusted to fit geologic environment
- Fluid must have significant gellation so as not to be a easily flowable fluid
- Backside mud is closer in appearance to a “grout” than a traditional drilling fluid
- Backside mud must advance with the drill string as drilling progresses
- Technique must be initiated from the beginning and maintained until total depth is reached
- The primary objective for drilling is to capture high quality geologic information

Questions

Thank You!!

Be Safe!!

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