How to Drill a Well
or
What I know about this hole boring job.
Wellbore Construction

• How deep?
• Where is it?
• What do you want to do with it?
How to Drill a Well - Part 1

- Determine location
  - Geology
  - Legal
  - Economic

- Prepare site
  - Survey
  - Clear
  - Level
  - Water source
  - Reserve pit
  - Roads
  - Reclamation
  - Dig cellar
  - Dig rat hole and mouse hole
  - Set conductor pipe
How to Drill a Well - Part 2

• Move in rig up (MIRU) drilling rig
  – Rigs are portable
  – Assembly

• Drilling
  – Spud
  – Keep a sharp bit on bottom
  – Add joints every 30 feet
  – Tripping
  – Use mud
    • Liquid
      – Oil
      – Water
    • Pneumatic
      – Air
      – Natural gas
      – Nitrogen

• Drill surface hole
How to Drill a Well - Part 3

• Run surface pipe
  – Protect fresh water
  – Anchor BOPE
• Cement surface pipe
  – WOC
  – Nipple up BOPE
• Drill out of surface pipe
  – Leak off test
• Drill ahead (turn to the right)
• Evaluation while drilling
  – Mud logging
  – Coring
  – MWD
  – Drill stem tests (DST)
How to Drill a Well - Part 4

• Trouble
  – Kicks and blow-outs
  – Lost circulation
  – Stuck pipe
  – Fishing
  – Mechanical breakdown
  – Lost hole

• Run intermediate casing
  – Protects hole
    • Sloughing
    • High pressure
    • Low pressure
    • Salt
  – A liner is casing that doesn’t reach the surface

• Cement intermediate casing
• Drill out of intermediate casing
How to Drill a Well - Part 5

• Drill ahead
• Reach total depth (TD)
• Evaluate
  – Logging
    • Electrical
    • Acoustical
    • Radioactive
  – DST
• Three things can happen
  – Production is found
  – Dry hole
  – Learned science
How to Drill a Well - Part 6

• Lay down drill pipe and BHA
• If a keeper
  – Run production casing
  – Cement
• If a dry hole
  – Plug and abandon (P&A) as per regulatory requirement and prudent operators procedures
• Rig down move out (RDMO) drilling rig
• If a keeper
  – MIRU Completion Unit
  – Complete well
  – Stimulate
  – Run completion equipment
• If a dry hole - Oh well.
Directional Possibilities

S-Shaped Well
Slant Well
Re-entry
Horizontal Well
Short Radius
Production Zone

Courtesy of Baker Hughes Inteq
Side Force and Tilt Angle

Resultant Force at Bit

Side Force at Bit

Side Force at Stabilizer

Formation Anisotropy

Hole Gauge

Bit Tilt Angle

Hole Axis

Courtesy of Baker Hughes Inteq
Formation Navigation

- Multiple depths of investigation for quantitative determination of formation resistivity ($R_t$)
- Early bed boundary detection
- A near bit inclinometer, enabling quick response to inclination changes
- A steerable motor system, permitting variable build rates for up to 15°/100ft
- Dual azimuthal gamma ray sensors 180° apart, providing high and low side measurements

Courtesy of Schlumberger
Slide and Rotary Modes

- **Slide Mode**
  - Used for “deviating”
- **Wellbore Trajectory**
  - Controlled curvature
  - Controlled direction
  - No drill string rotation

- **Rotary Mode**
  - Used for “going straight”
- **Wellpath**
  - Behavior same as a rotary drilling assembly
  - Hole slightly over size

Courtesy of Baker Hughes Inteq
Overall Drilling Rig Diagram
Rig Equipment

- **Power**
  - Motors
  - Compound

- **Hoisting**
  - Drawworks
  - Blocks and Tackle
  - Mast
  - Substructure

- **Circulation System**
  - Mud Pumps
  - Capacity
  - Solids Control System

- **Rotary Table**

- **Drill String**
  - Swivel and Kelly
  - Drill Pipe
  - Bottom Hole Assembly
  - Bit

- **Well Control**
  - Blow-out Prevention Equipment

- **Ancillary**
  - Instruments and Doghouse
Colorado School of Mines

- Established in 1874 in Golden, CO as a public institution of higher education
- CSM is devoted to Earth, Energy, and the Environment
- 4,500 students
  - 3,300 undergraduates
  - 1,200 graduates
- Thirteen degree granting departments or divisions
- SuperSchool offered July 11-29, 2011 on the Mines Campus

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