Drilling Fluids

Remove cuttings
cool and clean bit
lubricate drill assembly
control formation pressure
maintain wellbore stability
prevent lost circulation

} **Uses**

Types of Drilling Fluids

- Water-based muds
  - –Most common and least costly
  - –Bentonite, dispersants, and NaOH added
- Oil-based mud; lots of +'s and –'s (see handout)
- Air drilling (see handout) <1000 psi, 500-800 cfm
  - -Dry air
  - -Misting
  - -Foam

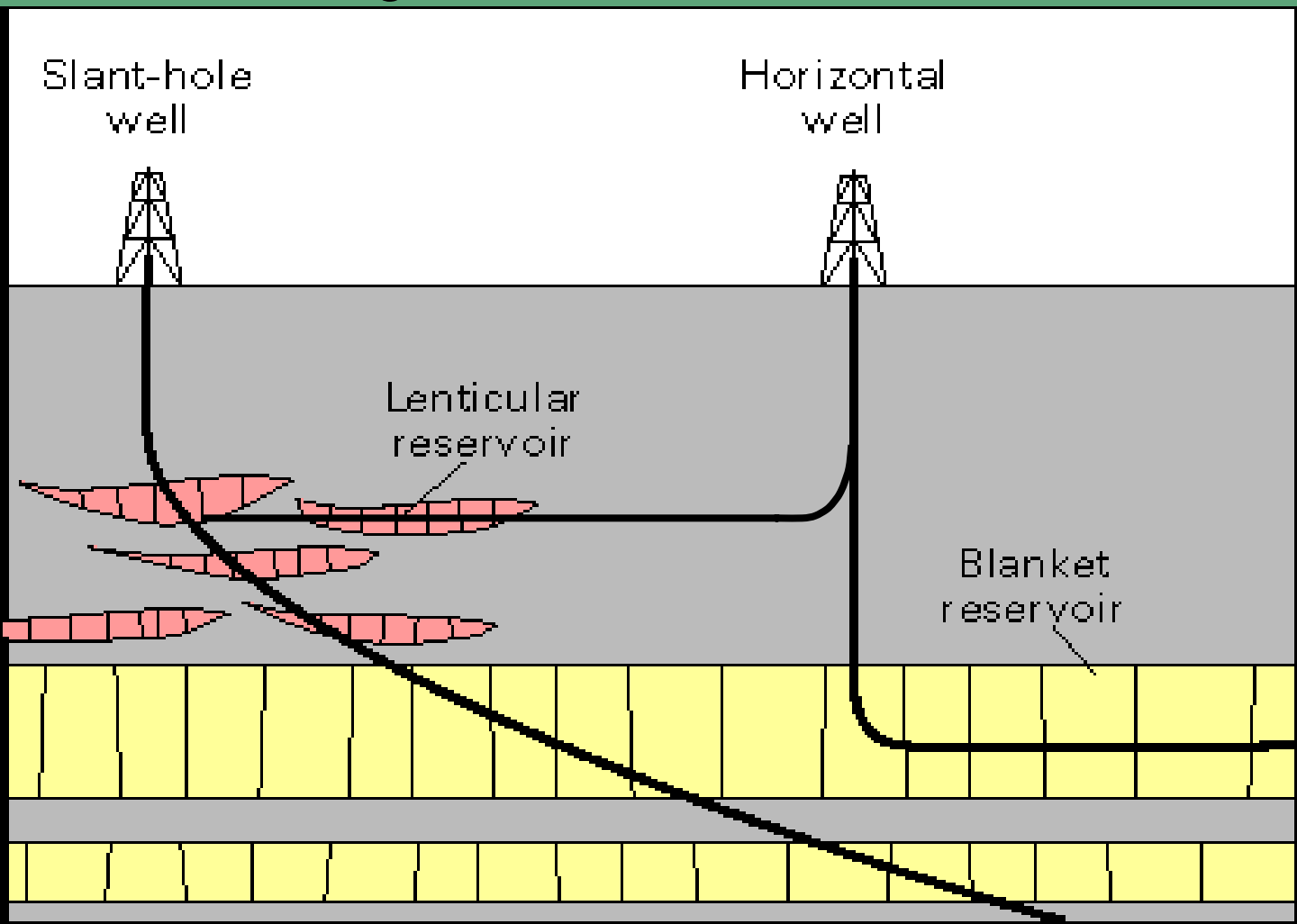
Table 1. Mud Density Measurements Comparison

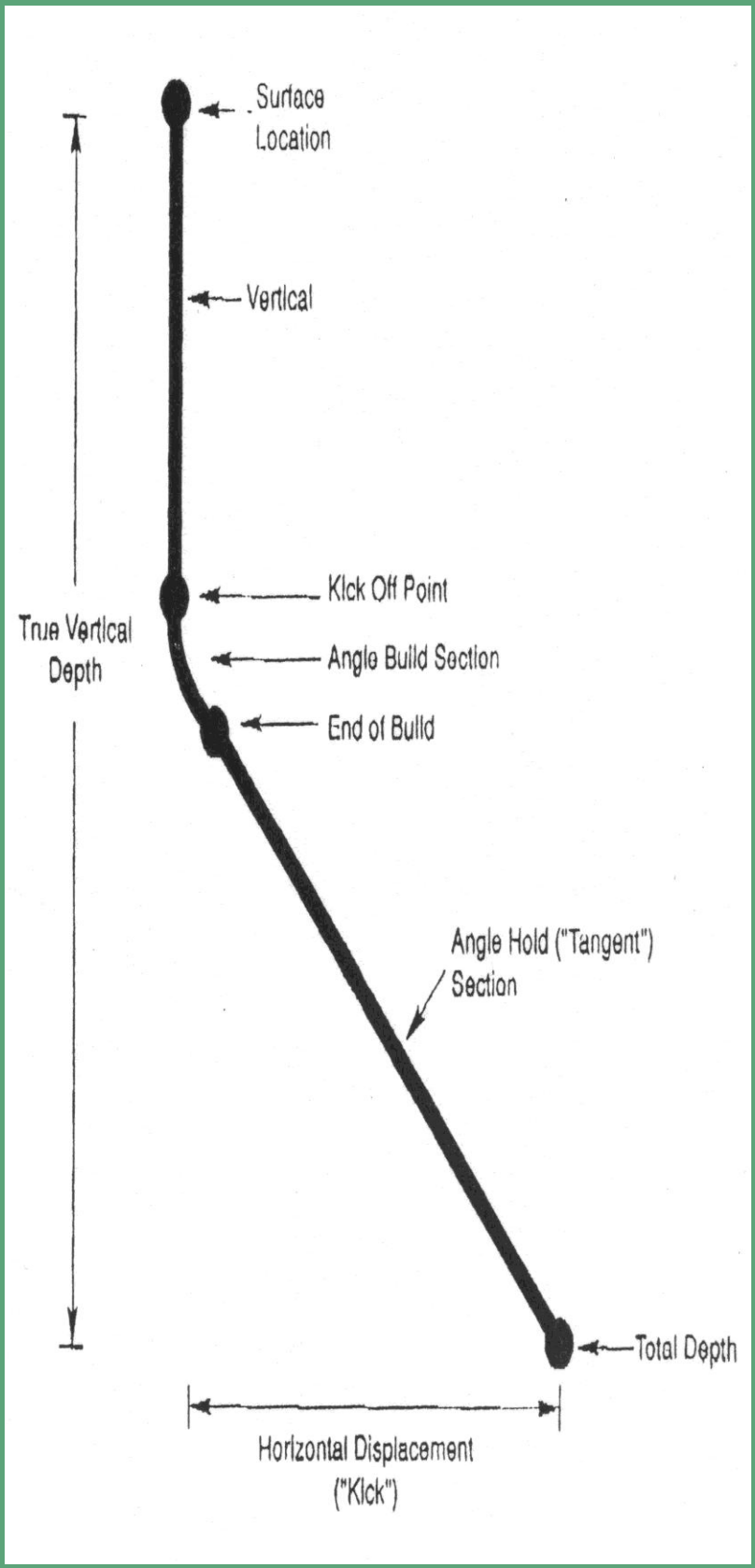
ppg	S.G.	psi/ft	pcf
8.0	0.96	0.416	59.84
8.335	1.0	0.433	62.35
9.0	1.08	0.468	67.32
10.0	1.20	0.520	74.80
11.0	1.32	0.572	82.28
12.0	1.44	0.624	89.76
13.0	1.56	0.676	97.24
14.0	1.68	0.728	104.72
15.0	1.80	0.780	112.20
16.0	1.92	0.832	119.68
16.67	2.0	0.867	124.69
17.0	2.04	0.884	127.16
18.0	2.16	0.936	134.64
19.0	2.28	0.988	142.12
19.23	2.31	0.9999	143.84
20.0	2.40	1.040	149.60

Drilling a Well

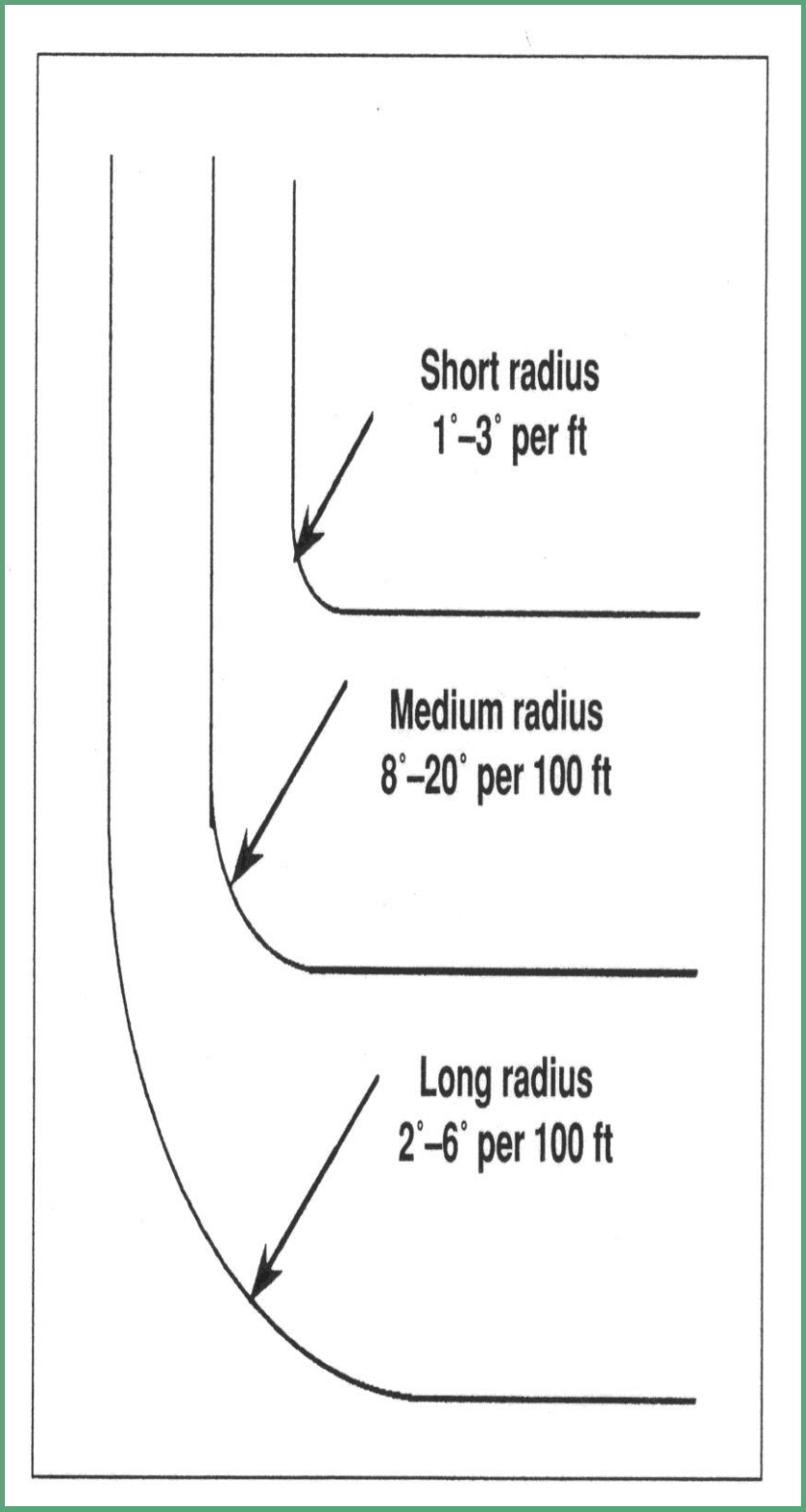
Whether drilling vertical or horizontal, making hole depends on:

- Dip of beds
- Hardness and rock composition
- Bit design
- Drilling parameters
- Faulting
- Fracturing





Terminology of a directionally drilled well (slant-hole)

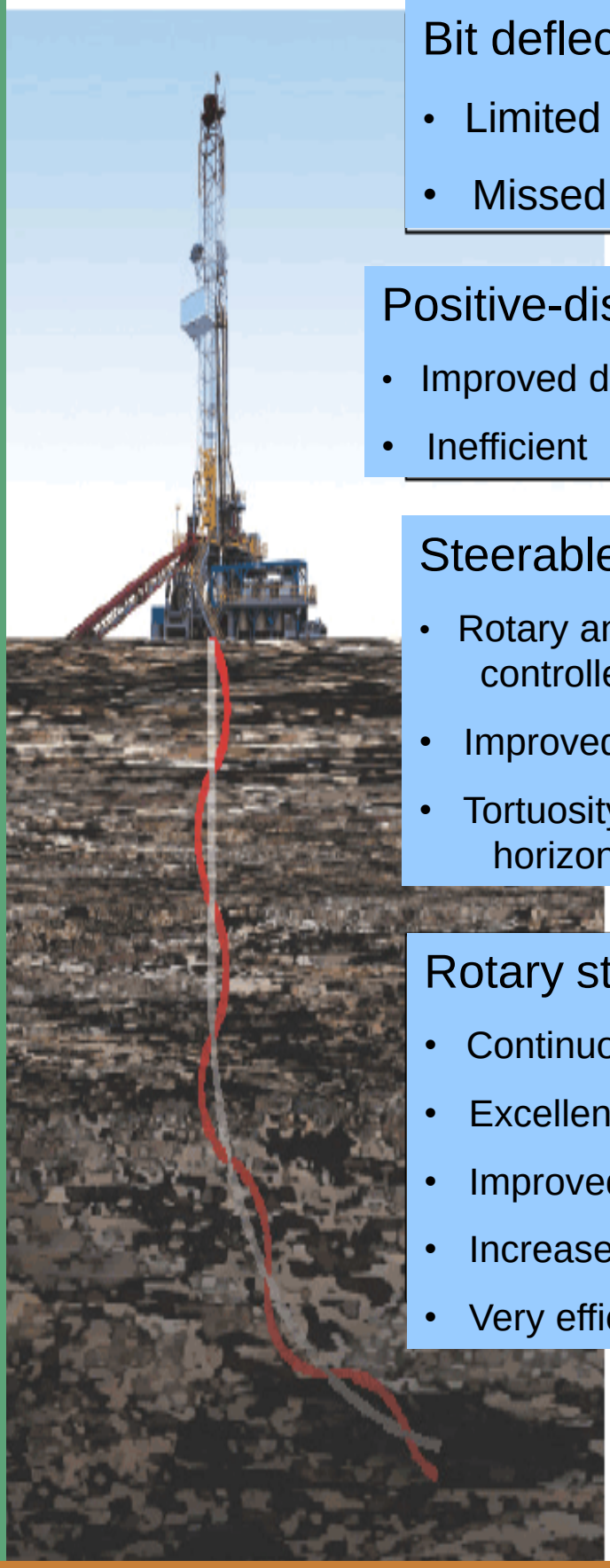


Short laterals ~ few hundred ft.

Intermediate laterals ~ few thousand ft.

Long laterals ~ several thousand ft.

Typical build rates for horizontal wells



Bit deflection using **whipstocks**

- Limited control
- Missed targets

Positive-displacement motor **PDM**

- Improved directional control
- Inefficient

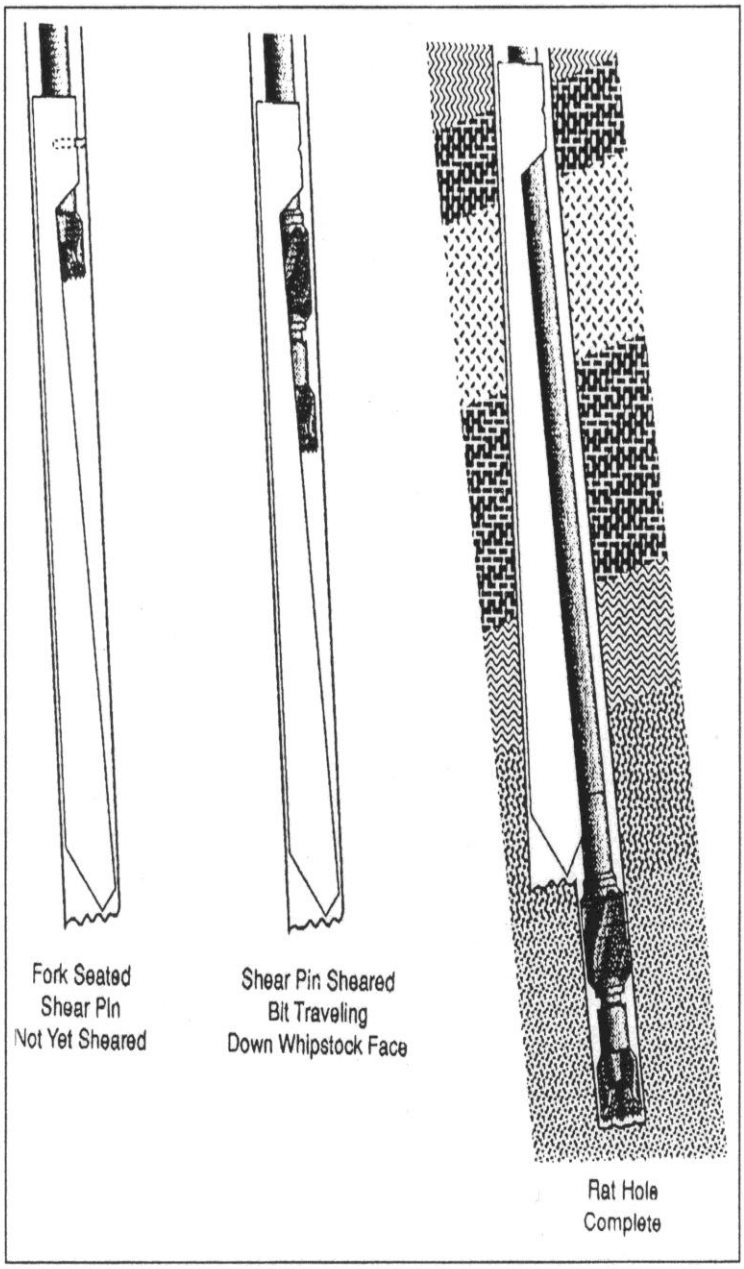
Steerable drilling motor

- Rotary and ***sliding*** modes controlled at surface
- Improved directional control
- Tortuosity from *slide* drilling limits horizontal reach

Rotary steerable system

- Continuous rotation
- Excellent directional control
- Improved borehole quality
- Increased rate of penetration
- Very efficient (but costly)

History of deviated/horizontal drilling



Bit deflection using **whipstocks**

- Limited control
- Limited applications
- Early but still utilized technology

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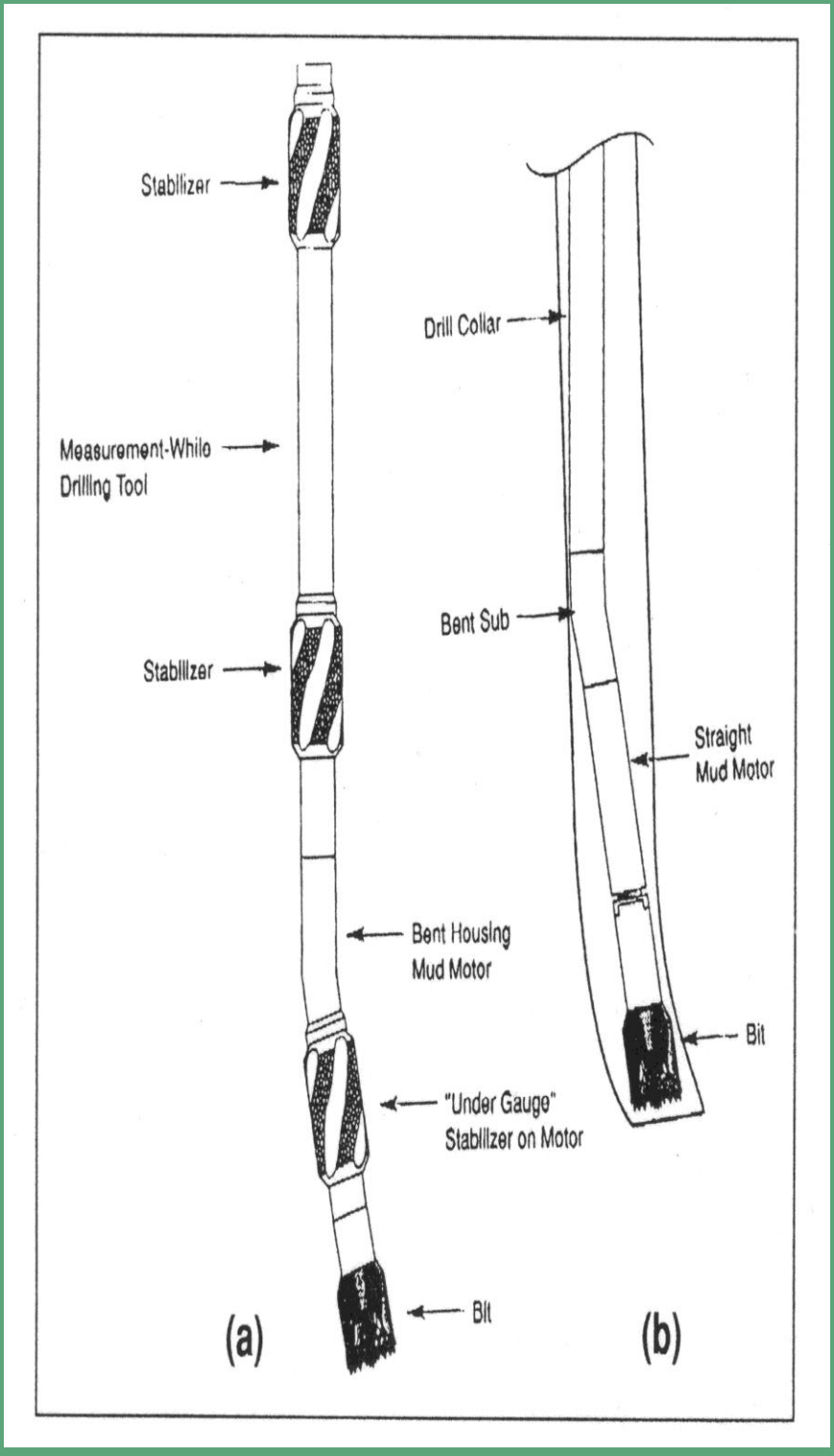
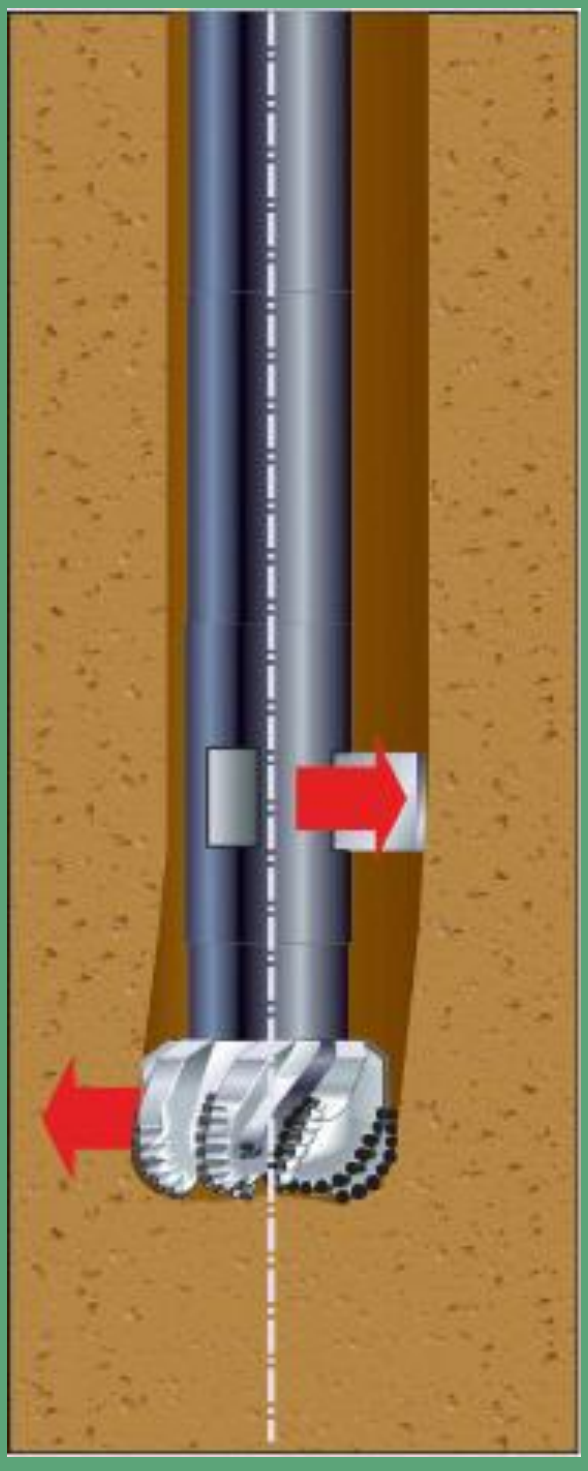
PDM or positive displacement (mud) motor

Figure 1 A turbine converts hydraulic power in the drilling fluid into rotary mechanical energy.



These directional drilling assemblies use down-hole hydraulic motors (mud motors) which utilize circulated drilling mud pumped from the surface. The tool is positioned and then held stationary while hole is made by sliding the drill string downward and forward.

Steerable (non-rotating) drilling assemblies

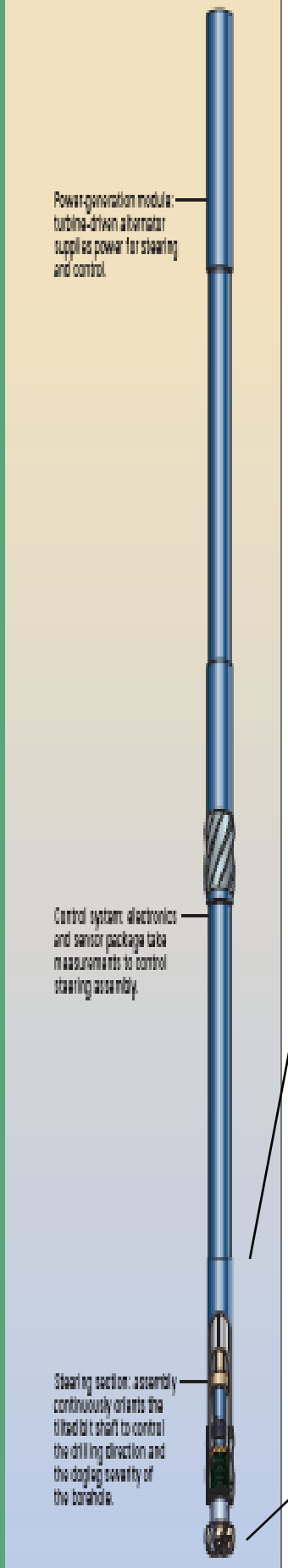


Pushing a bit

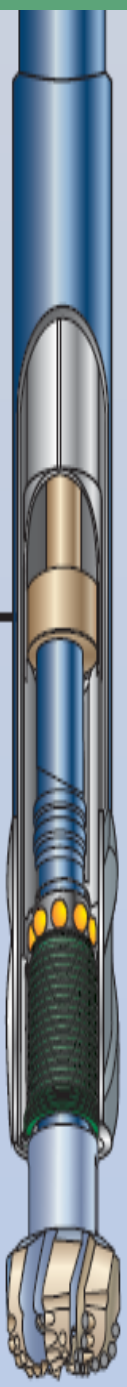
Pointing a bit

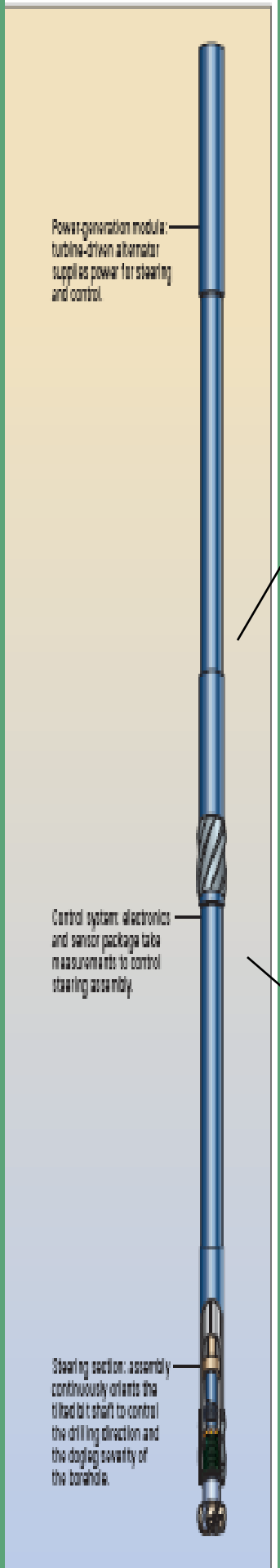
Steerable drilling methods

PDC bit on a modern rotary steerable drill system RSD)



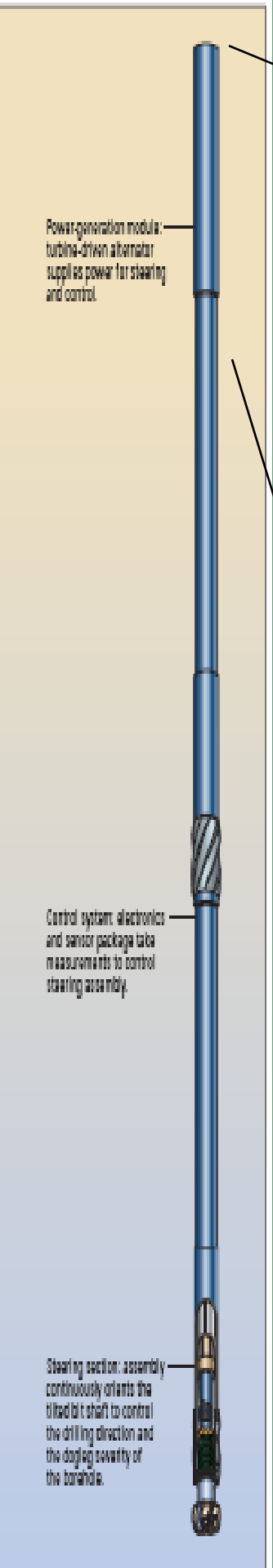
Steering section: assembly continuously orients the tilted bit shaft to control the drilling direction and the dogleg severity of the borehole.





MWD & LWD

- measure while drilling
- Log while drilling

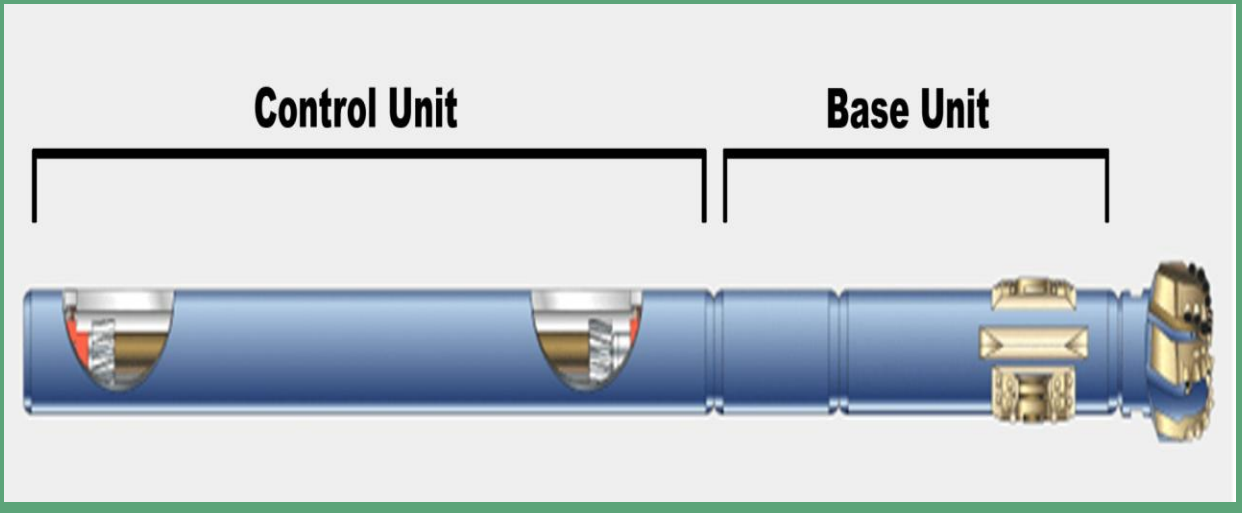


Power-generation module: turbine-driven alternator supplies power for steering and control.

Alternatively, some systems use hydraulic power from the mud system to power the bit (mud motor)

What?

Horizontal wells.



Schlumberger Power Drive Rotary Steerable Assembly

Mud Motor + MWD + LWD =

COSTLY horizontal wells.

Grand Directions, LLC
Short Radius Drilling Tool

Reduce the cost of horizontal wells.

Rotary steerable assembly

Rotary steerable systems in 4 ¾”, 6 ¾”, 9” & 11” from Schlumberger

Major drilling tool suppliers

- Schlumberger
- Baker-Hughes
- Halliburton