钻井新技术

- 水平井钻井技术（**Horizontal well Drilling)**
- 大位移井 **ERD Drilling Tech. (Extended Reach Displacement)**
  - 旋转导向钻井、地质导向钻井技术
- 分枝井钻井技术（**Multilaberal well Drilling**）
- 欠平衡钻井技术**(Underbalanced Drilling)**
- 套管钻井技术
- 连续油管的应用**(Coiled tubing Tech.)**
- 保护油气层的钻井完井技术
- 深井复杂井钻井技术

水平井的分类

- 长半径水平井
  - 造斜率：2° /30m－6 ° /30m
  - 应用范围：水平位移较大的水平井
  - 钻具组合：常规的钻具组合（弯接头、弯外壳、多稳定器钻具组合）
  - 测量工具：常规测量工具（单点、多点、有线和无线MWD）
  - 水平段长度：取决与可用的工艺技术水平
  - 完井：常规完井技术，完井方式取决于油藏条件

水平井的分类

- 中半径水平井
  - 造斜率：6° /30m－20 ° /30m
  - 应用范围：水平位移较大的水平井
  - 钻具组合：常规的钻具组合（弯外壳、导向钻具组合）
  - 测量工具：常规测量工具（单点、多点、有线和无线MWD）
  - 水平段长度：300m－900m
  - 完井：常规完井技术，完井方式取决于油藏条件

水平井的分类

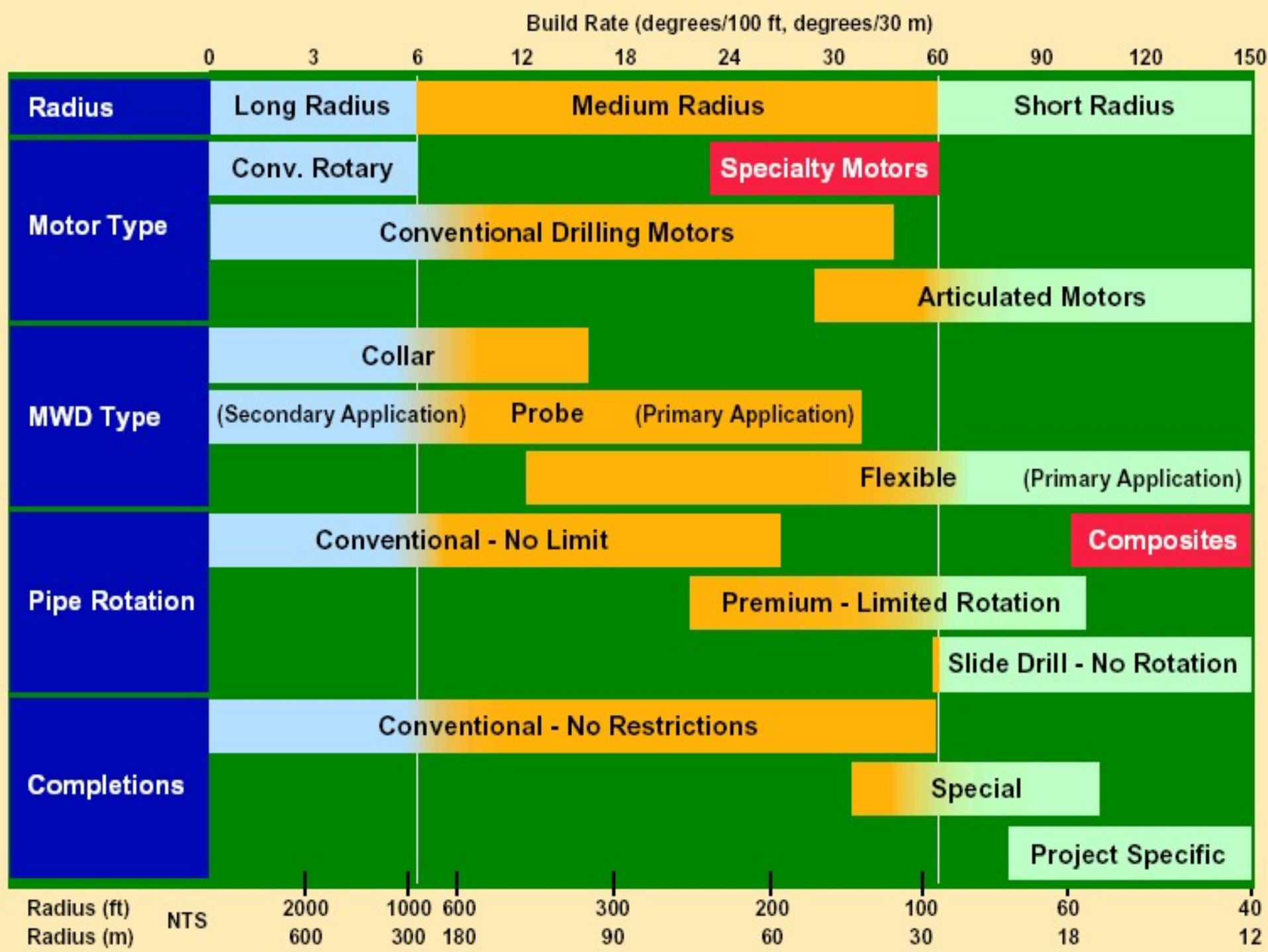
- 短半径水平井
  - 造斜率：1° /m－10 ° /m
  - 应用范围：水平位移不大的水平井
  - 钻具组合：特殊钻具组合（铰接马达、挠性钻杆等）
  - 测量工具：特殊的测量工具
  - 水平段长度：60m－120m
  - 完井：多数裸眼

水平井的用途

- 开发低渗透油气藏
  - 增加泄油长度
  - 增大传导率
  - 通过水平井穿透低渗透储层中的天然裂缝，亦可对水平井进行增产处理，可显著提高油气采收率
- 开发裂缝性油气藏
- 开发薄层的油气藏
- 减少气、水锥进，延长无水开采期
- 改善蒸汽驱效率，开发稠油油藏
  - SAGD

水平井的用途

- 提高聚合物驱油效果
  - 水平井能大大提高注入能力和区域扫油效率，尤其对聚合物和活性剂的注入很有效。
- 改善水驱和注水
  - 利用水平井开发，压力降不像直井那样集中在某一点上，而是分散在比较长的泻油井段上，因而压力降较小，油水界面的变形也比较小,含水量缓慢增加。
- 避免出砂，或者降低出砂几率
  - 出砂量与井眼附近的流体流速成正比。由于水平井的泻油长度远远大于垂直井的泻油长度，因而水平井井壁附近的流体流速远远小于直井井壁附近的流体流速

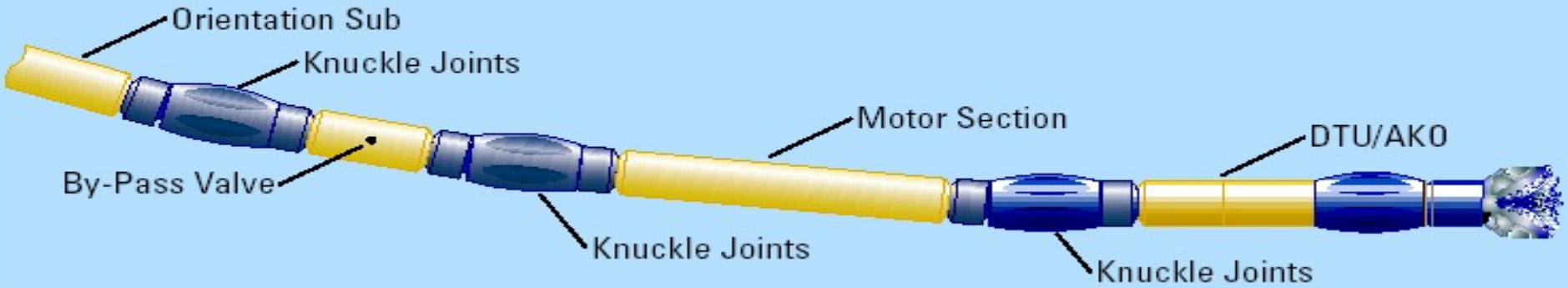

Build Rate (degrees/100 ft, degrees/30 m)
0
3
6
12
18
24
30
60
90
120
150
Radius
Long Radius
Medium Radius
Short Radius
Motor Type
Conv. Rotary
Specialty Motors
Conventional Drilling Motors
Articulated Motors
MWD Type
Collar
(Secondary Application)
Probe
(Primary Application)
Flexible
(Primary Application)
Pipe Rotation
Conventional - No Limit
Composites
Premium - Limited Rotation
Slide Drill - No Rotation
Completions
Conventional - No Restrictions
Special
Project Specific
Radius (ft)
NTS
2000
1000
600
300
200
100
60
40
Radius (m)
600
300
180
90
60
30
18
12

Re-entry Drilling Capability by Well Profile

Motor Size	Hole Size	Casing Size	Motor Type	Articulated	Maximum BUR Sliding (Degree/100 ft)	Maximum BUR Rotary (Degree/100 ft)	Rotate Below Curve	Maximum Curve BUR for Push Through Rotation in Lateral (Degree/100 ft)
3¾"	4½"-4¾"	5½"-6⅝"	Short Radius	Yes	143	NA	No	NA
3⅛"	3⅞"-4⅛"	4½"-5"	Short Radius	Yes	95	NA	No	NA
3⅛"	3⅞"-4¾"	4½"-5"	M1XL Ultra (R3)	No	34 (3⅞" hole) 40 (4¾" hole)	30	Yes	72*
3⅛"	3⅞"-4¾"	4½"-5"	M1XL Ultra (R4)	No	15 (3⅞" hole) 23 (4¾" hole)	23	Yes	72*
4¾"	5⅞"-6"	6⅝"-5"	Short Radius	Yes	143	NA	No	NA
4¾"	5⅞"-6⅛"	6⅝"-7"	Short Radius (30 m)	Yes	71	NA	Yes	72*
4¾"	5⅞"-6¼"	6⅝"-7"	M1X Ultra	No	25	20	Yes	72*
4¾"	5⅞"-6¼"	6⅝"-7"	M1XL Ultra	No	8	8	Yes	25
4¾"	5⅞"-6¼"	6⅝"-7"	M2P/XL Ultra	No	8	8	Yes	25

*Ability to rotate below the curve requires project-specific evaluation, premium tubulars and special rig-site procedures.

Short Radius Drilling Motor



水平井钻井技术

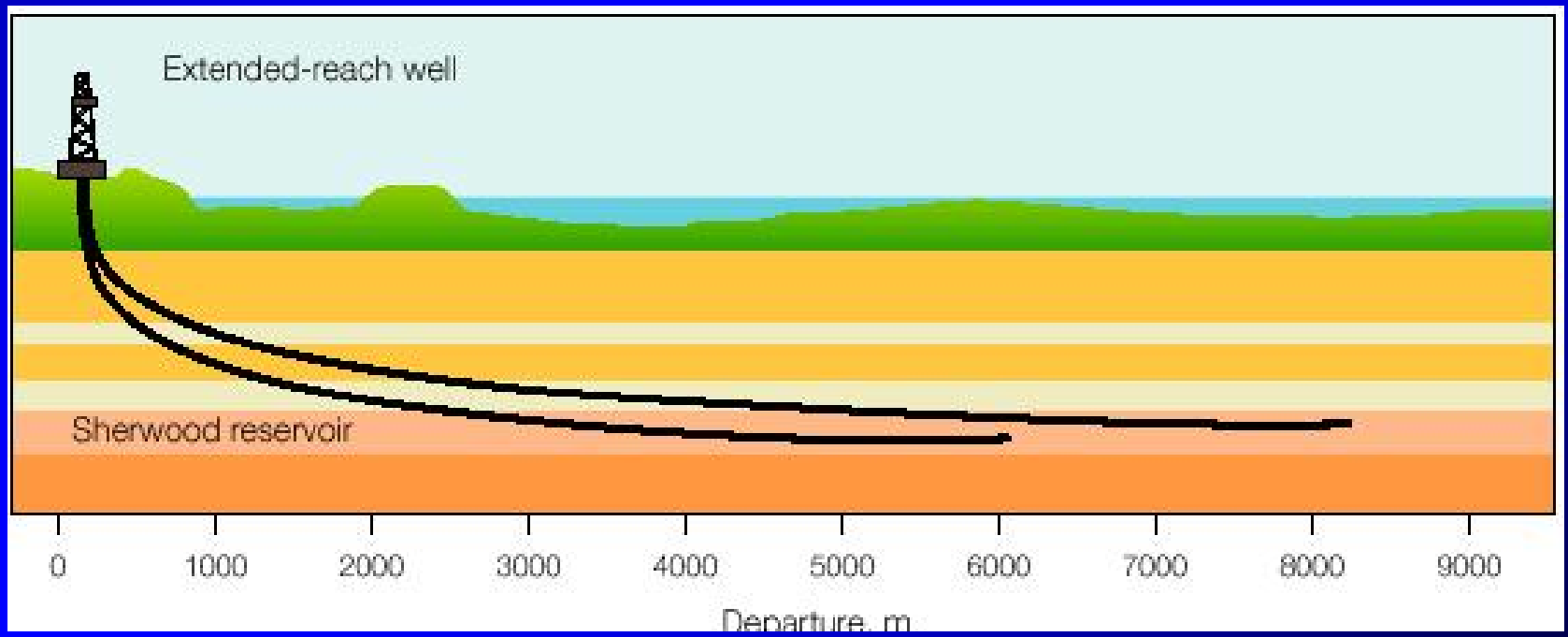
大位移井钻井技术

主要内容

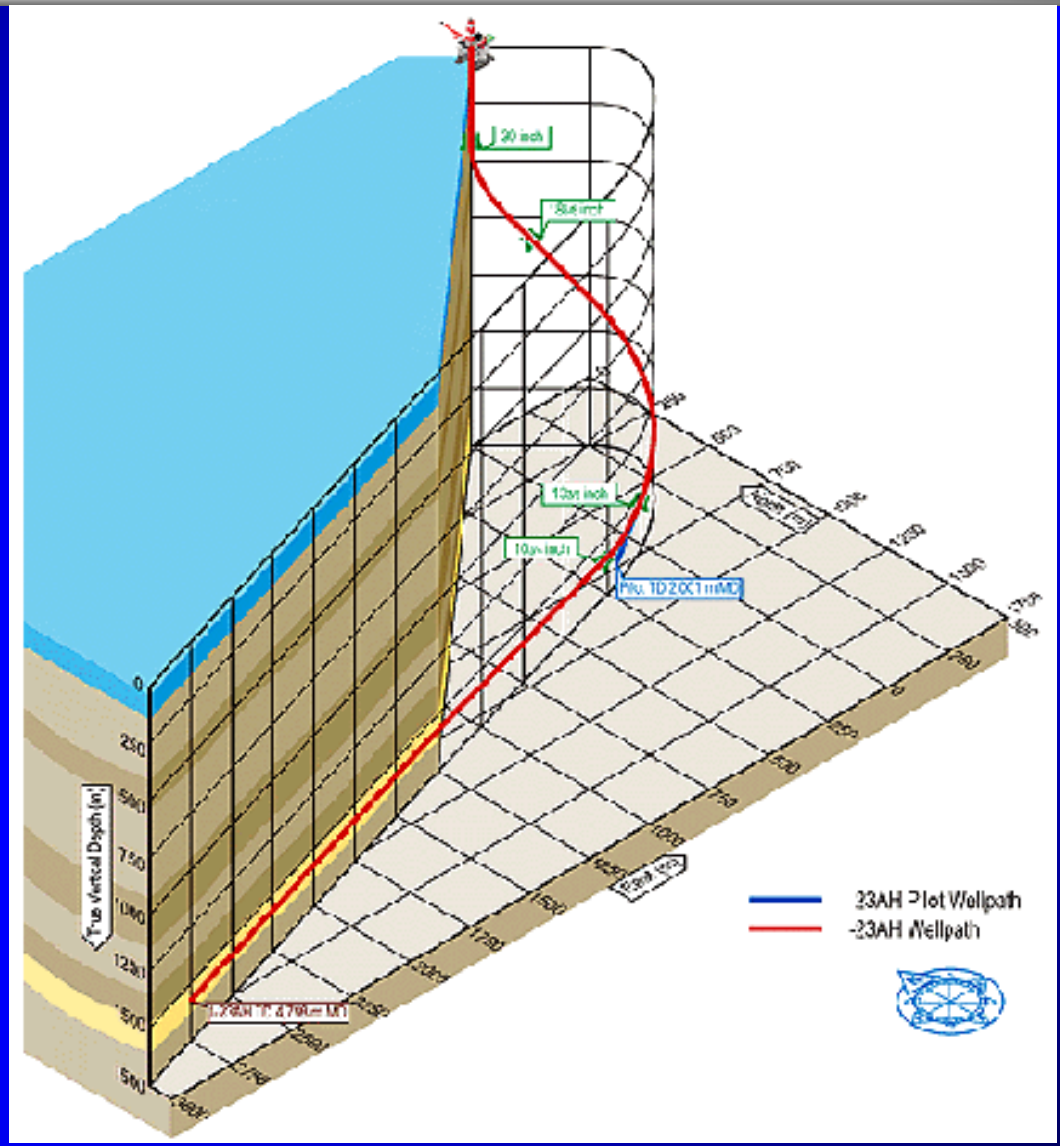
- 大位移井的基本概念
- 大位移井在国内外的应用情况
- 大位移井的关键技术
  - 井壁稳定
  - 轨迹设计
  - 摩阻扭矩分析
  - 钻柱设计
  - 轨迹控制
  - 井眼净化
  - 技术套管下入及保护

大位移井的定义

- 大位移井
  - 测深/垂深>2的井
  - 水平位移/垂深>2的井（Designer Well）

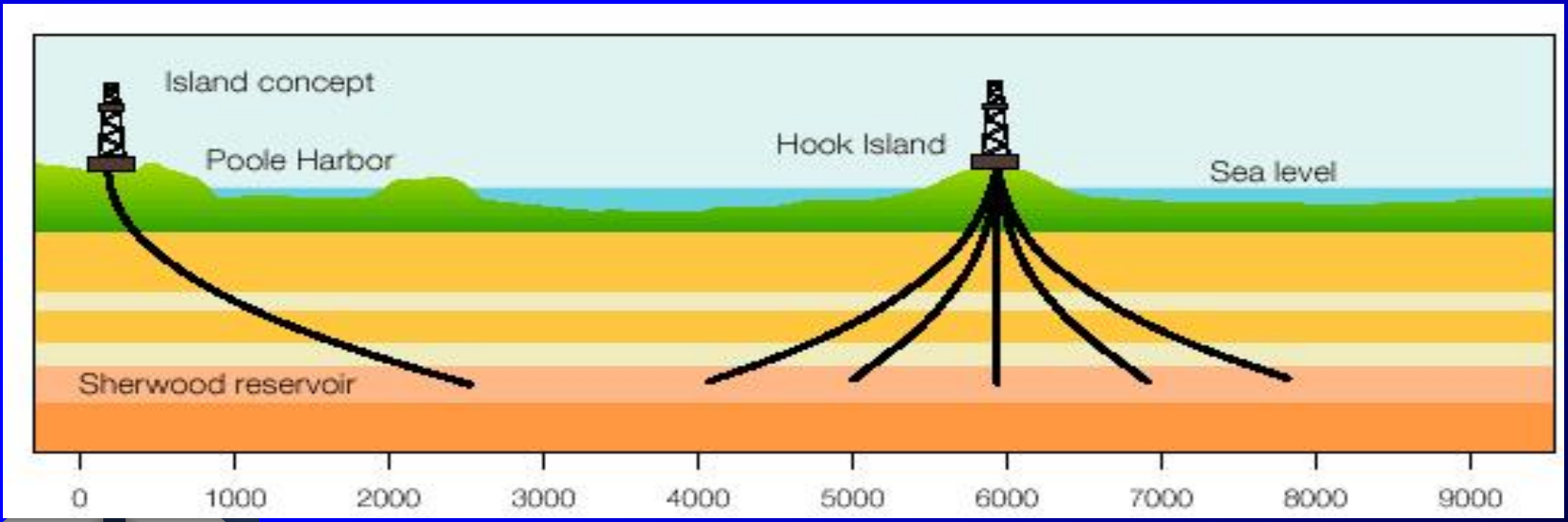


Designer Well



大位移井的应用范围

- 应用范围：
  - 用大位移井开发海上油田，大量节省费用；
  - 海边开采近海油藏；
  - 不同类型的油气藏钻大位移井提高经济效益；
  - 地面存在大范围障碍的区域。



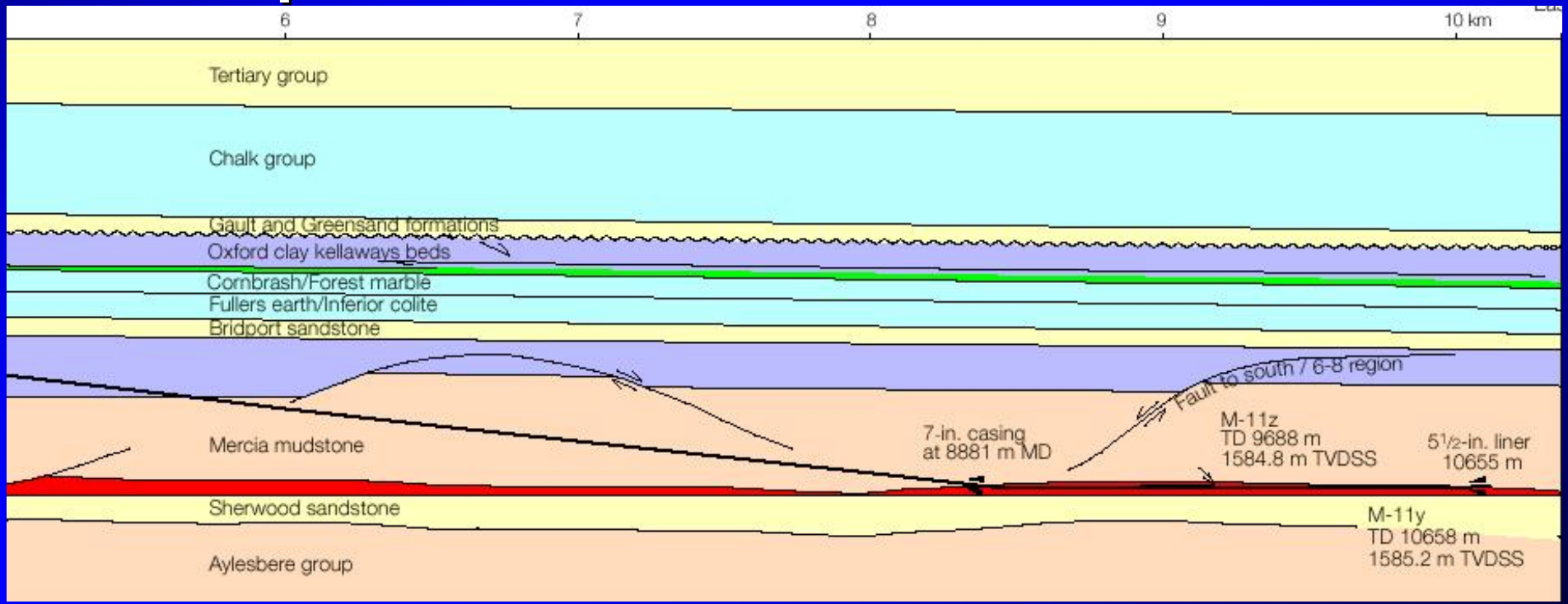
大位移井的应用范围

Wytch farm, Southern England



大位移井的应用范围

- 世界上水平位移最长的井**M11,水平位移10114，垂深1585.2m，测深10658m**
- **Kop:232m**



大位移井的应用

- 几个油田两种开发方案对比

地　区	原开发方案	大位移井方案经济效益	时间
美国加州 Pedernales 油田	在 Irene 平台西北 3.2km 建第二个平台	节省 1 亿美元	1991
挪威 Statfjord 油田北块	水下开发费用为 1.5 亿美元	三口大位移井，节省 4.5 千万美元	1993
挪威 Oseberg 油田	两个平台间距 15km，水下方案 2.7 千万美元	节省 3.2 百万美元，采收率提高到 64%	1995
英国南部 Wytch Farm 油田	建人工岛	海油陆采，节省 1.5 亿美元，提前 3 年投产	1996

大位移井在国内外的应用

- 数据截至到**1997年**
- 最大水平位移超过**10km**
- 主要分布于英国的**Wytch farm**油田和挪威的北海油田

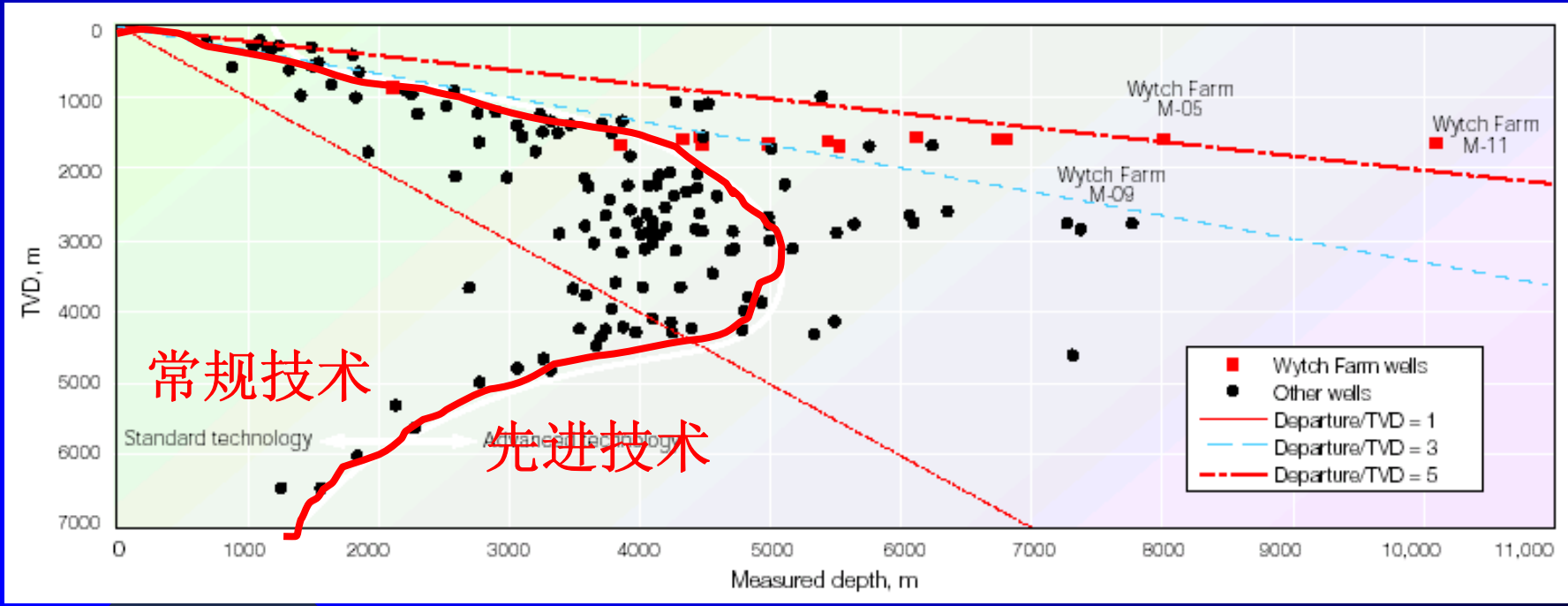
Rank	Horizontal displacement, ft	Measured depth, ft	TVD, ft	Operator	Well	Location
1*	33,182	34,967	5266	BP	M-11	UK, Wytch Farm
2*	26,446	30,308	9554	Phillips	Xijiang 24-3	South China Sea
3*	26,361	28,593	5285	BP	M-05	UK, Wytch Farm
4	25,764	30,600	NA	Norsk Hydro	30/6 C-26	North Sea
5*	25,108	27,241	NA	BP	M-09	UK, Wytch Farm
6*	23,917	28,743	9147	Statoil	33/9 C-2	North Sea
7*	22,369	24,442	NA	BP	M-03	UK, Wytch Farm
8*	22,180	24,690	5243	BP	M-02	UK, Wytch Farm
9	21,490	26,509	NA	Norsk Hydro	30/6 B-34	North Sea
10*	21,289	25,991	NA	Norsk Hydro	30/6 C-17	North Sea
11	20,966	24,670	9076	Amoco	SEER T-12	North Sea
12*	20,577	21,102	NA	Norsk Hydro	31/4 A-8A	North Sea
13*	20,577	25,010	NA	Norsk Hydro	30/9 B-30	North Sea
14*	20,514	22,907	5528	Total Austral	ARA S7/1	Tierra del Fuego, Arg.
15	20,289	25,164	NA	Norsk Hydro	30/6 B-6	North Sea
16*	20,151	25,541	NA	Norsk Hydro	30/6 C-24A	North Sea
17*	19,667	22,559	5324	BP	M-06	UK, Wytch Farm
18	19,209	23,786	8845	Statoil	33/9 C-3	North Sea
19*	19,030	23,835	NA	Norsk Hydro	30/9 B-48	North Sea
20*	18,758	24,540	13,940	BP	2/1 A-13	North Sea

大位移井在国内油田的应用

井　名	测深（m）	垂深（m）	水平位移（m）	位移/垂深
P30	4686	2026	3697	1.82
P31	4428	2082	3695	1.77
P32H	4540	1869	3631	1.94
P33	4491	2054	3652	1.78
A25H	3038	1496	1924	1.3
A26H	3715	1492	2997	2.01
大港油田张 17-1 井	3934	2999	2279	0.76
大港油田赵东 F-1 井	4420	3329	2624	0.79
大港油田红 9-1 井	2218	1150	1668	1.46
冀东乐 8×1 井			2000	1.23
胜利油田桩斜 314 井	3750	2636	2000	0.76

大位移井技术应用

- 随着水平位移与垂深比的增加，大位移的施工难度也逐渐增加，但随着技术的进步，大位移井水平位移的极限不断被打破。



钻大位移井的设备

- 大功率顶驱
- 大尺寸钻杆
- 改进钻机，增大钻机负荷和立根盒的容量
- 可变径稳定器、旋转导向钻井系统
- 先进的随钻测量系统（MWD、LWD）
- 地质导向系统（Geosteering tools）
- 需要大功率泵（输出排量1100gpm）
  - 从两台增加到3台、泵功率1600hp增加到2200hp；提高地面高压管汇的承压能力从5000psi提高到7500psi。

大位移井面临的理论问题

- 理论问题
  - 井眼轨迹优化设计
  - 井壁稳定理论
  - 摩阻扭矩分析
  - 环空流体学及环空携岩
  - 钻柱强度分析

大位移井的关键技术

- 降低摩阻扭矩的技术
  - 轨迹优化设计技术
  - 增加钻井液的润滑性
  - 减摩工具
  - 摩阻预测技术
- 钻柱设计
  - 钻具接头的平衡连接技术
  - 采用高摩擦系数的螺纹脂
  - 高扭矩接头
  - 高强度钻杆

大位移井的关键技术（续）

- 井壁稳定技术
  - 地层坍塌压力、地层压力、地层破裂压力
  - 井壁稳定风险评价
  - 钻井液与地层之间的水化作用
  - 井壁稳定风险评价
- 井眼净化技术
- 摩阻扭矩实时监测
- 技术套管下入及保护

大位移井轨迹控制

大位移井轨迹控制

- 螺杆
  - 高扭矩
- 旋转导向钻井系统
  - **Power Drive**
  - **Auto Trak**
- 地质导向工具
  - **GAMA RAY**
  - **LWD**
- **AIM（At Bit inclination Measurement）**

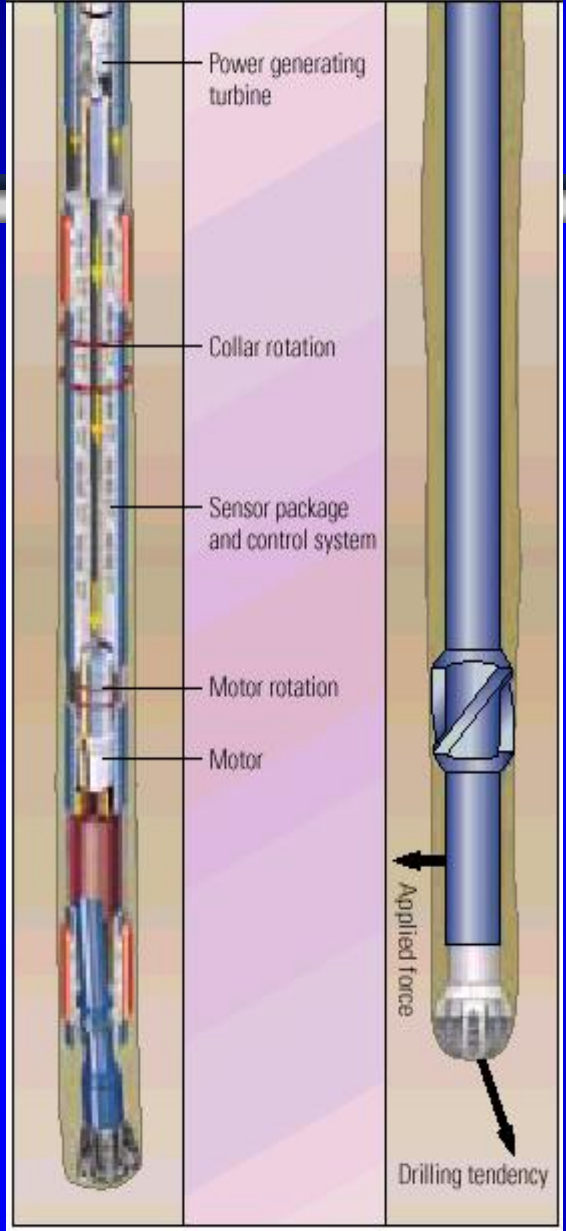
大位移井轨迹控制

- 滑动钻进面临的主要问题
  - 机械钻速低
  - 井眼净化不好
  - 滑动困难
  - 压差卡钻
  - 管柱屈曲和自锁
  - 井眼不规则
  - 易斜地层比较敏感

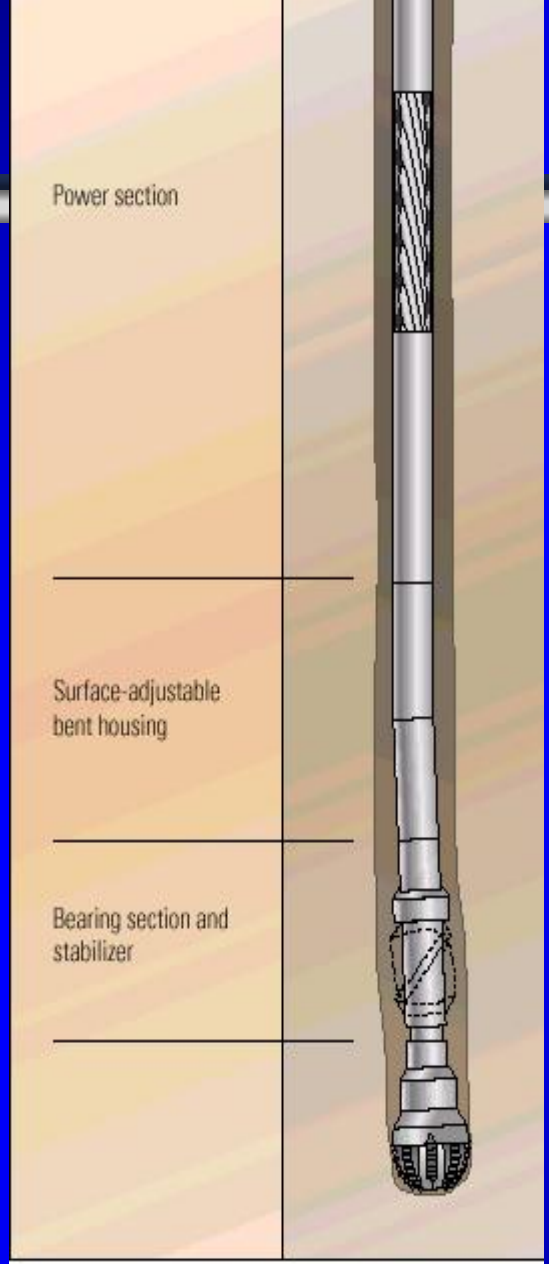
大位移井轨迹控制

- 旋转导向钻进提高钻速
  - 采用优化的钻头切削结构
  - 采用最优的钻井参数
  - 钻柱连续旋转
  - 不会因为滑动钻进而降低机械钻速
  - 井眼净化良好
  - 减少短起下的次数

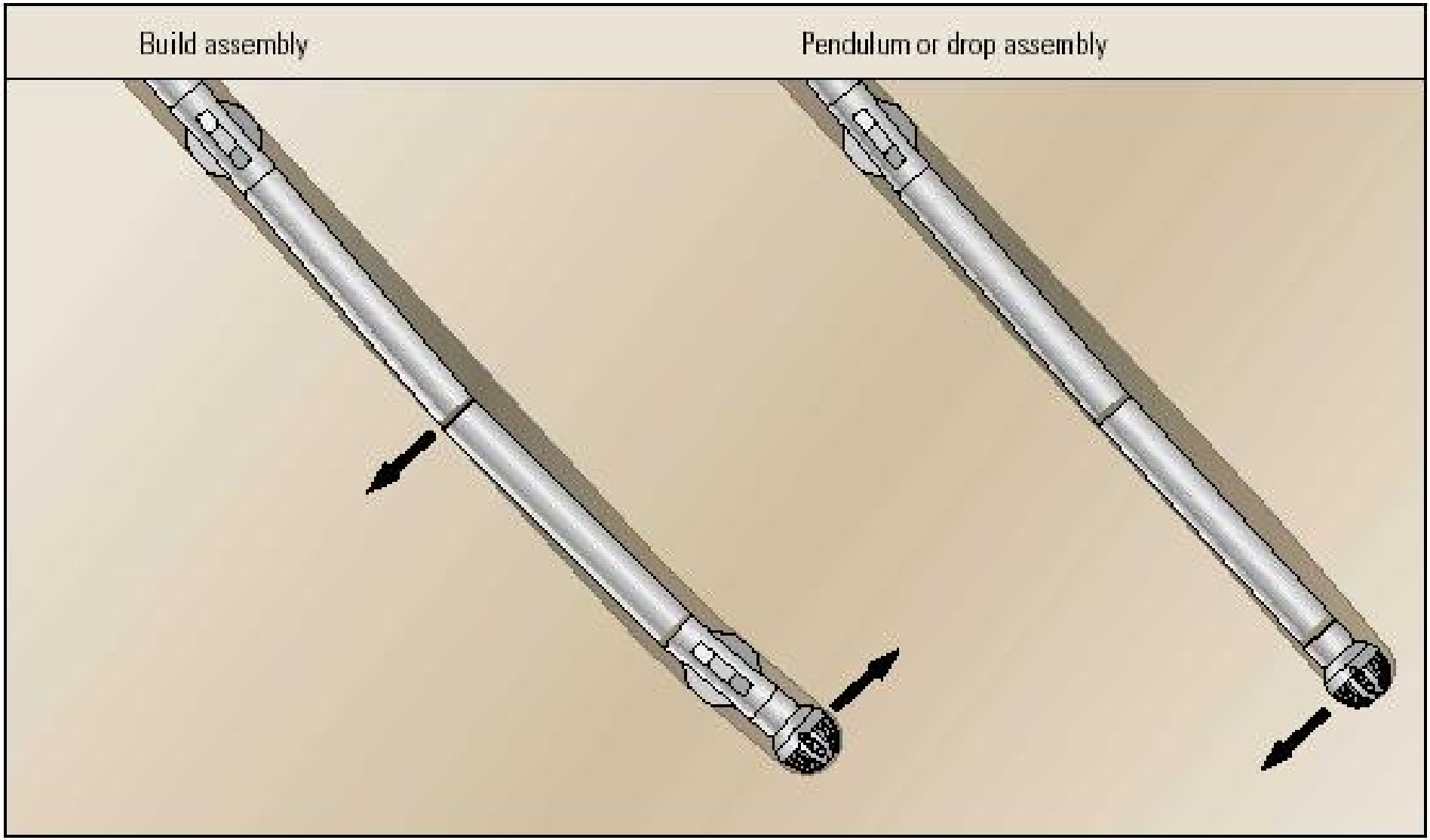




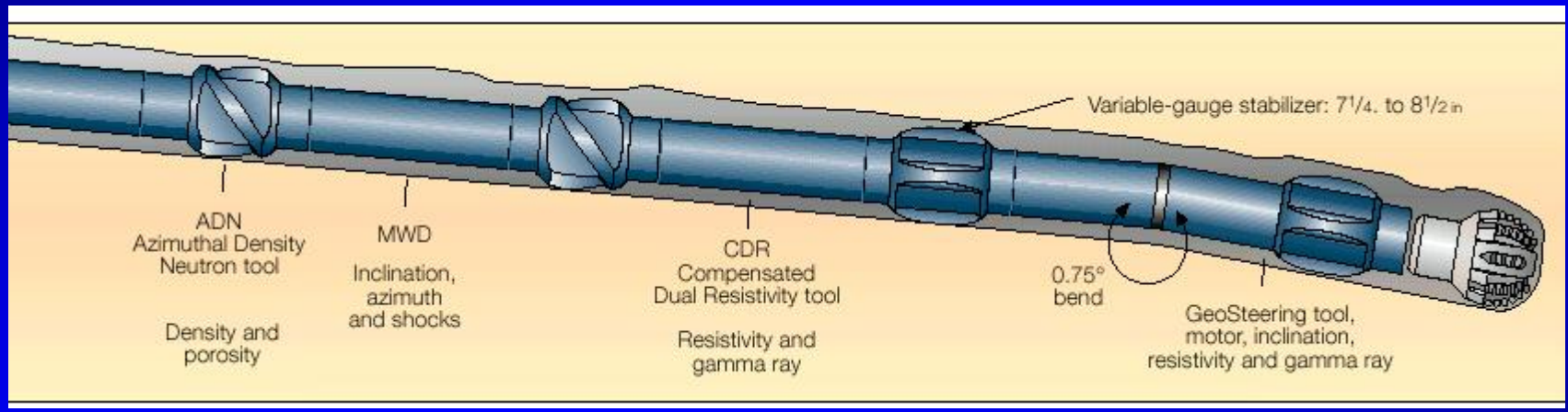
– Rotary steerable system designs characterized by their steady-state behavior. In point-the-bit systems *(left)*, the bit is tilted relative to the rest of the tool to achieve the desired trajectory. Push-the-bit rotary steerable systems *(right)*

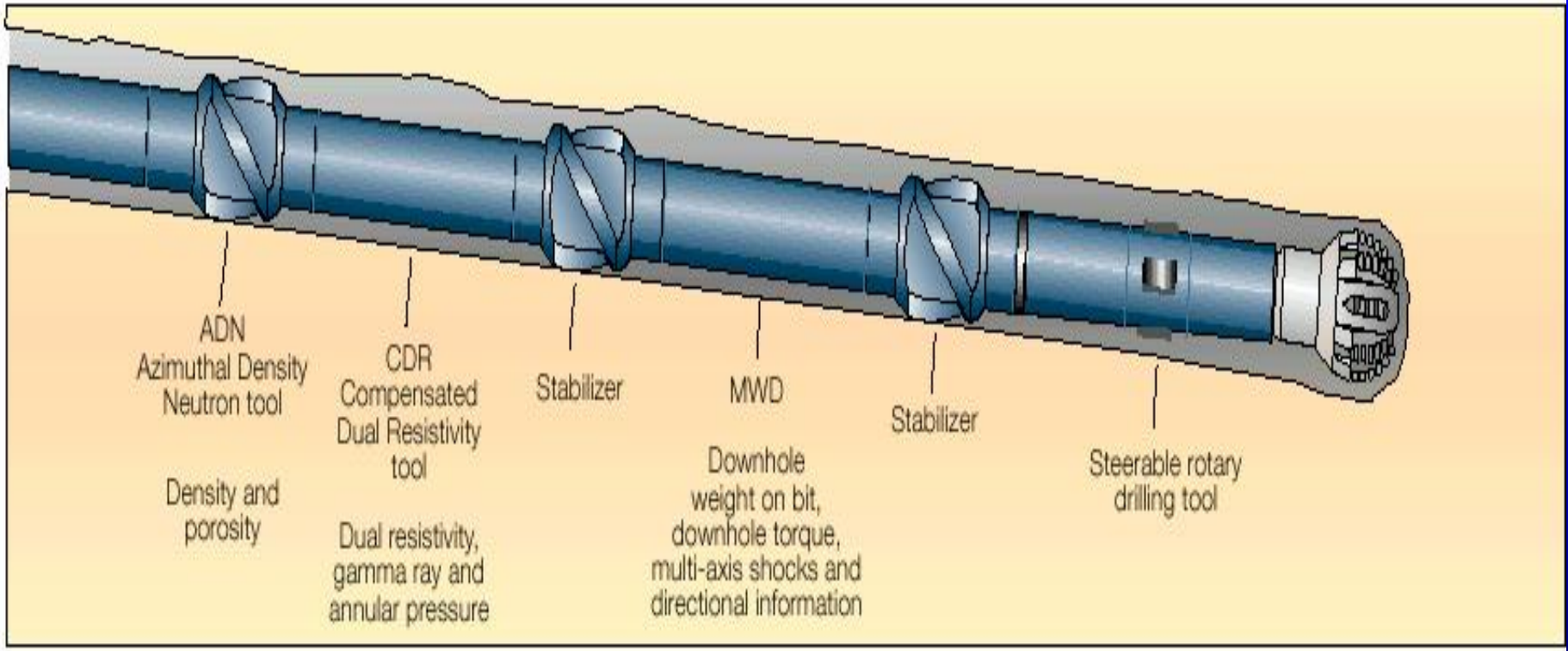


– Steerable BHA. This simple yet rugged PowerPak steerable assembly consists of a power-generating section, a surface-adjustable bent housing, a stabilizer and the drill bit.



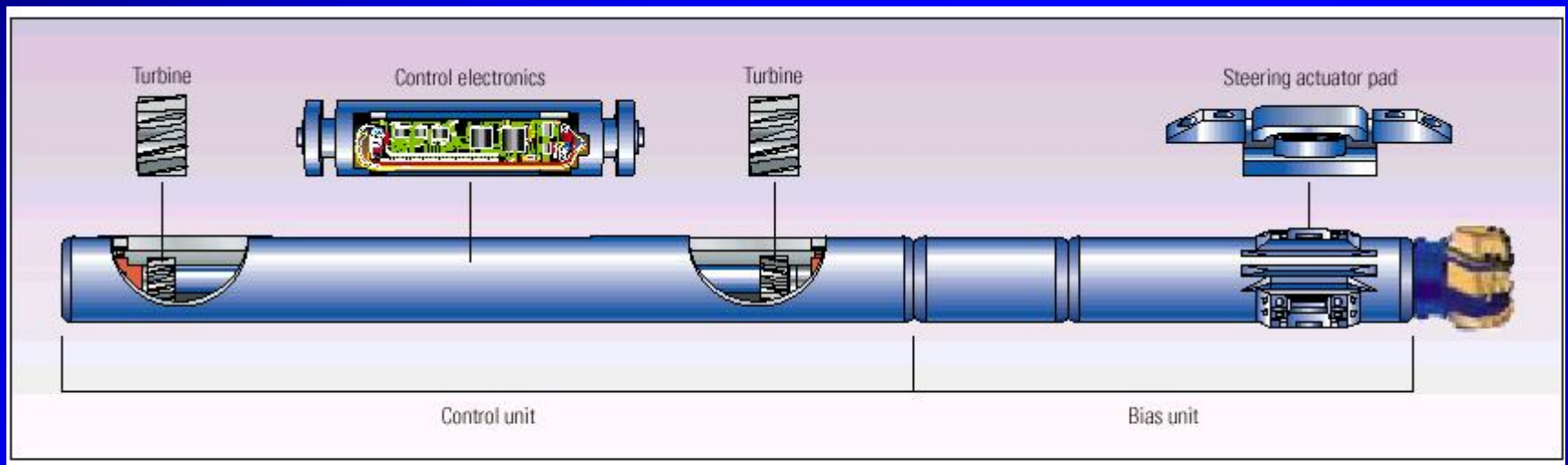
^ Changing direction without a downhole motor. Careful placement of stabilizers and drill collars allow the directional driller to build angle *(left)* or drop angle *(right)* without a steerable BHA. Generally, the placement and gauge of the stabilizer(s) and flexibility of the intermediate structure determine whether the assembly will build or drop.


Variable-gauge stabilizer: 7¼. to 8½ in
ADN
Azimuthal Density
Neutron tool
Density and
porosity
MWD
Inclination,
azimuth
and shocks
CDR
Compensated
Dual Resistivity tool
Resistivity and
gamma ray
0.75°
bend
GeoSteering tool,
motor, inclination,
resistivity and gamma ray



☐ *Steerable rotary assembly. A BHA with a steerable rotary drilling tool was the primary directional system for most of the 12 1/4-in. and 8 1/2-in. sections of Well M-11. The CDR tool was incorporated into the BHA design during the latter part of the 12 1/4-in. section to help identify the top of the reservoir and determine the 9 5/8-in. casing seat.*

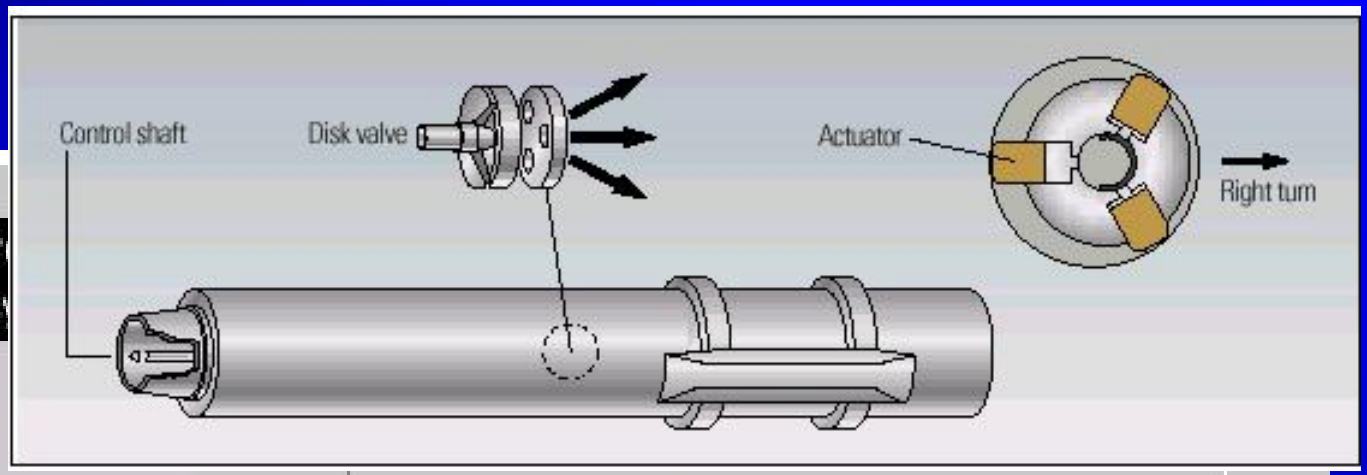
PowerDrive闭环轨迹控制工具

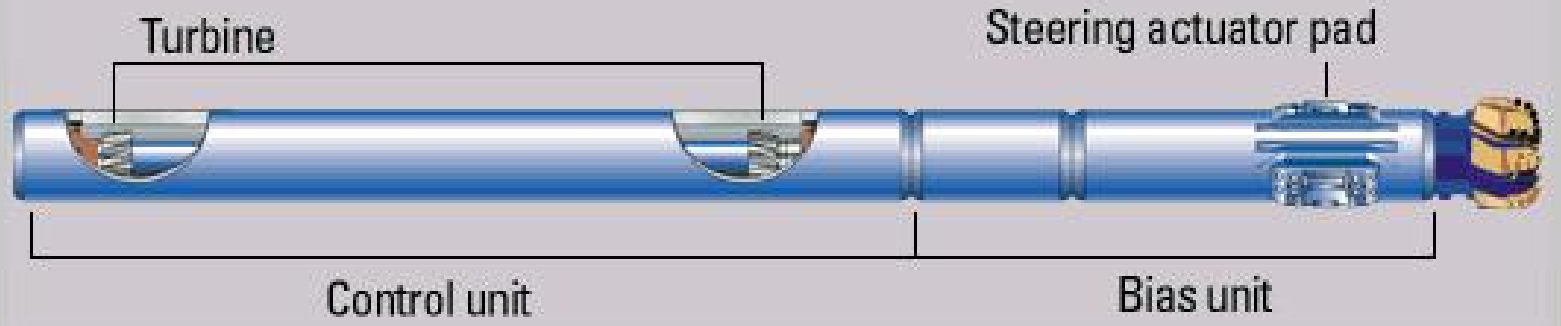


– The PowerDrive rotary steerable system.

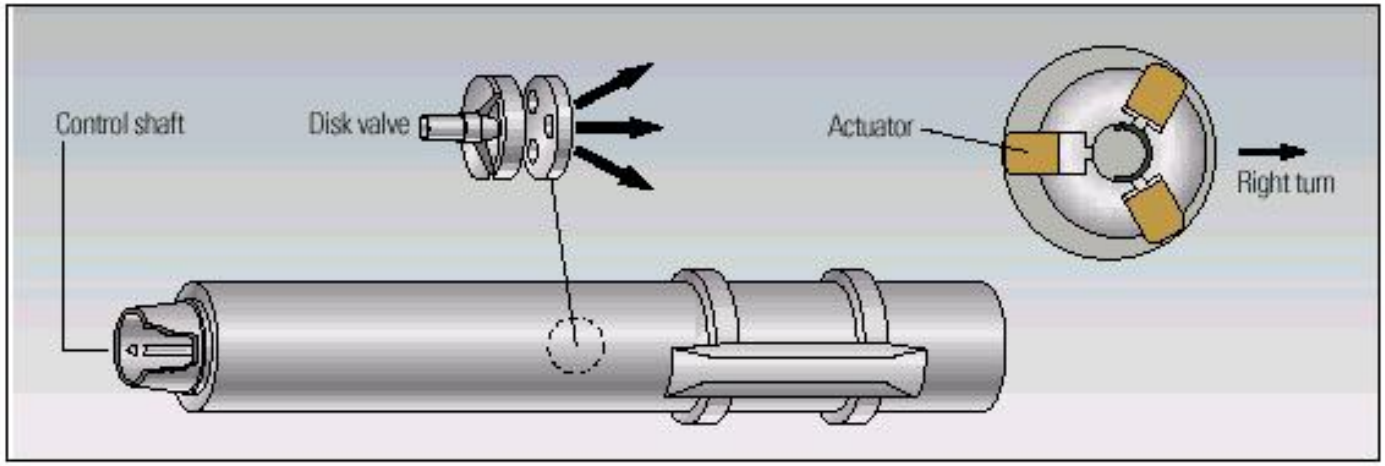
PowerDrive闭环轨迹控制工具

The PowerDriv
rotary drilling s





PowerDrive闭环轨迹控制工具

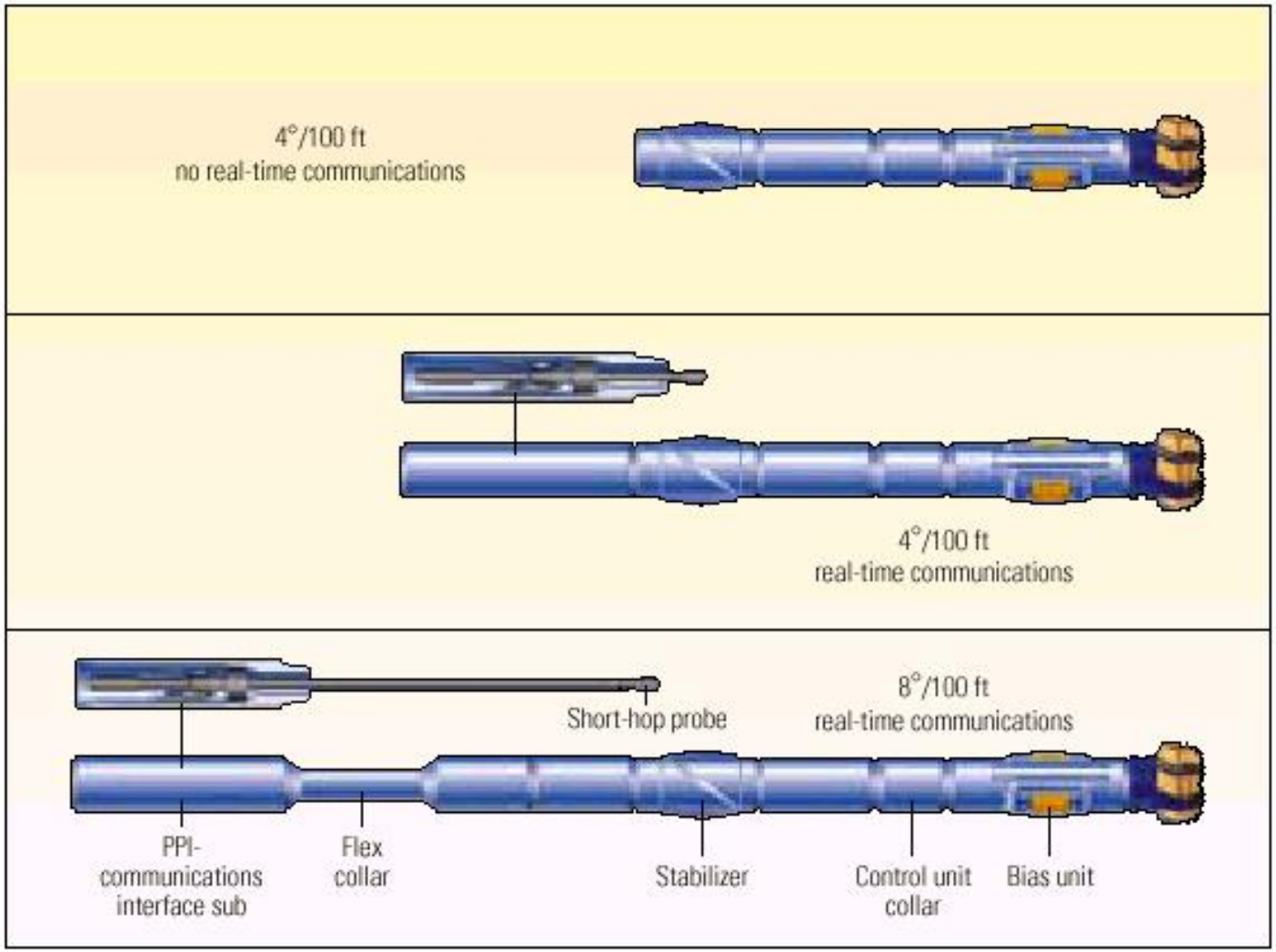






– Pushing the bit. Mud flow through a three-way disk valve actuates three external pads *(top)*. The pads push against the borehole at the appropriate point in each rotation to achieve the desired trajectory—in this case, turning right *(top right)*—and extend outward up to ⅜ in. [1 cm]. The illustrations at the bottom show the tool with the pads retracted *(left)* and extended *(right)*.

PowerDrive闭环轨迹控制工具



– BHA configurations. The PowerDrive system can be run without a real-time communications system *(top)*, with real-time short-hop communications *(middle)* or with a short-hop extender that allows real-time communications using a flex collar when a higher build rate is required *(bottom)*.

AutoTrak闭环轨迹控制工具

结构、原理

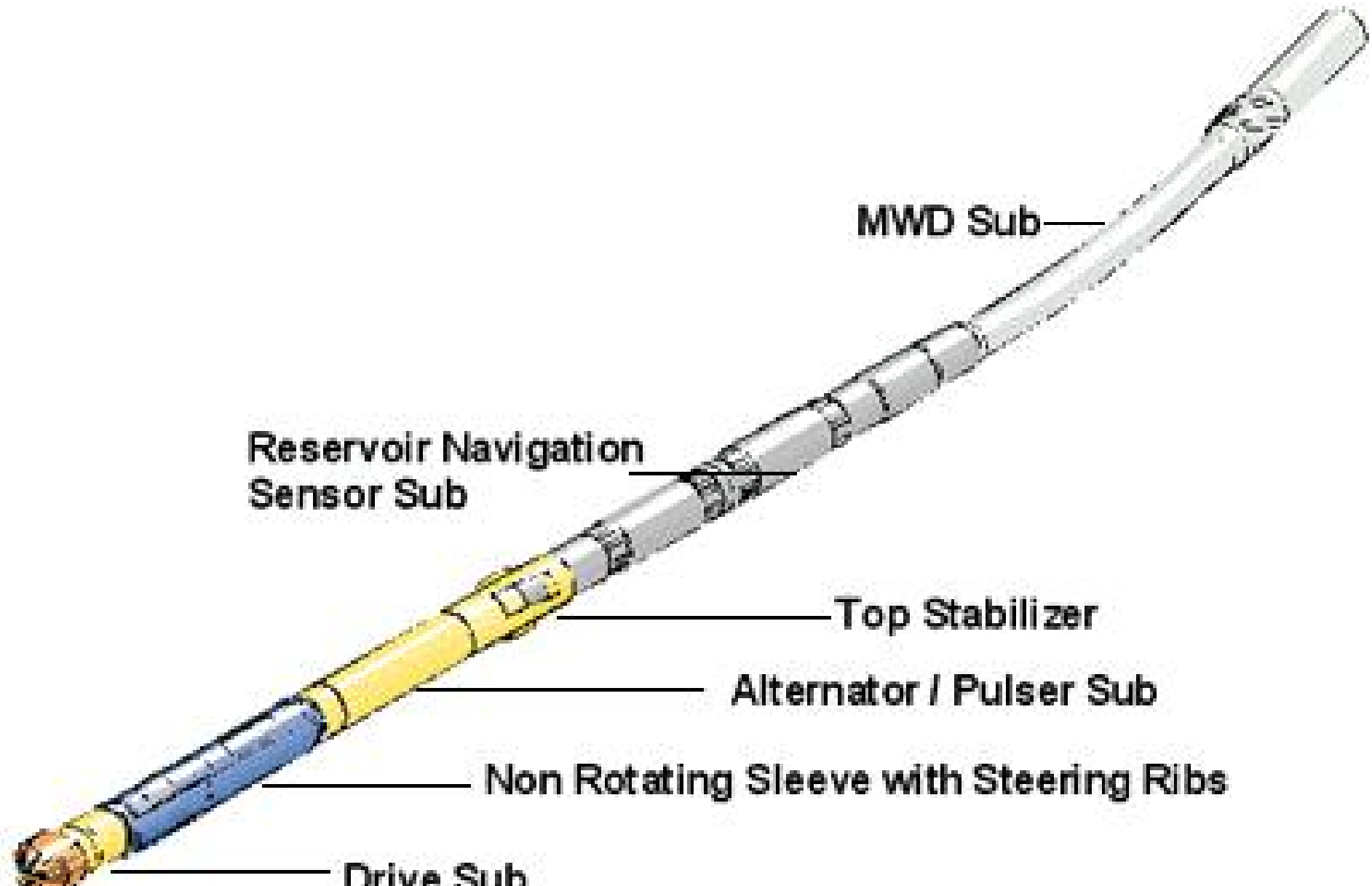
第三代改进

工作性能及特点

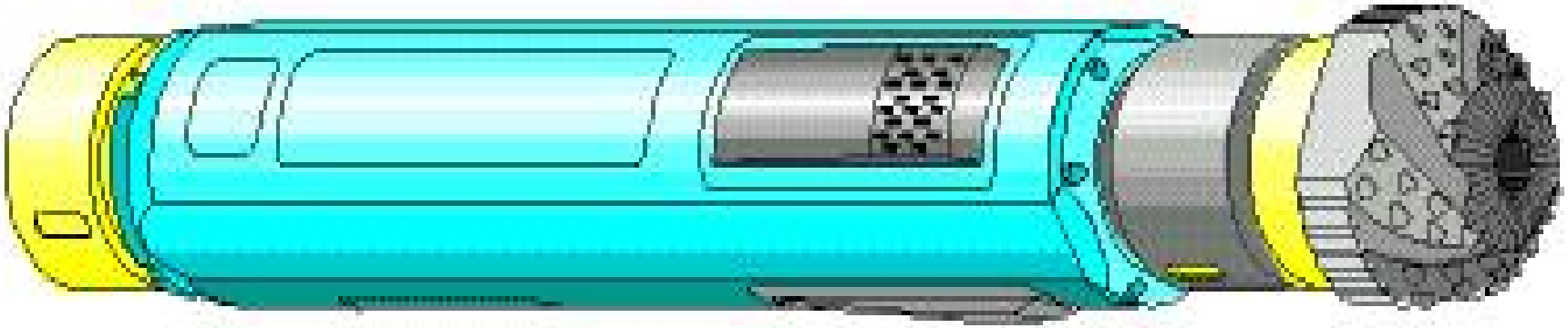
强化地质及工程测量

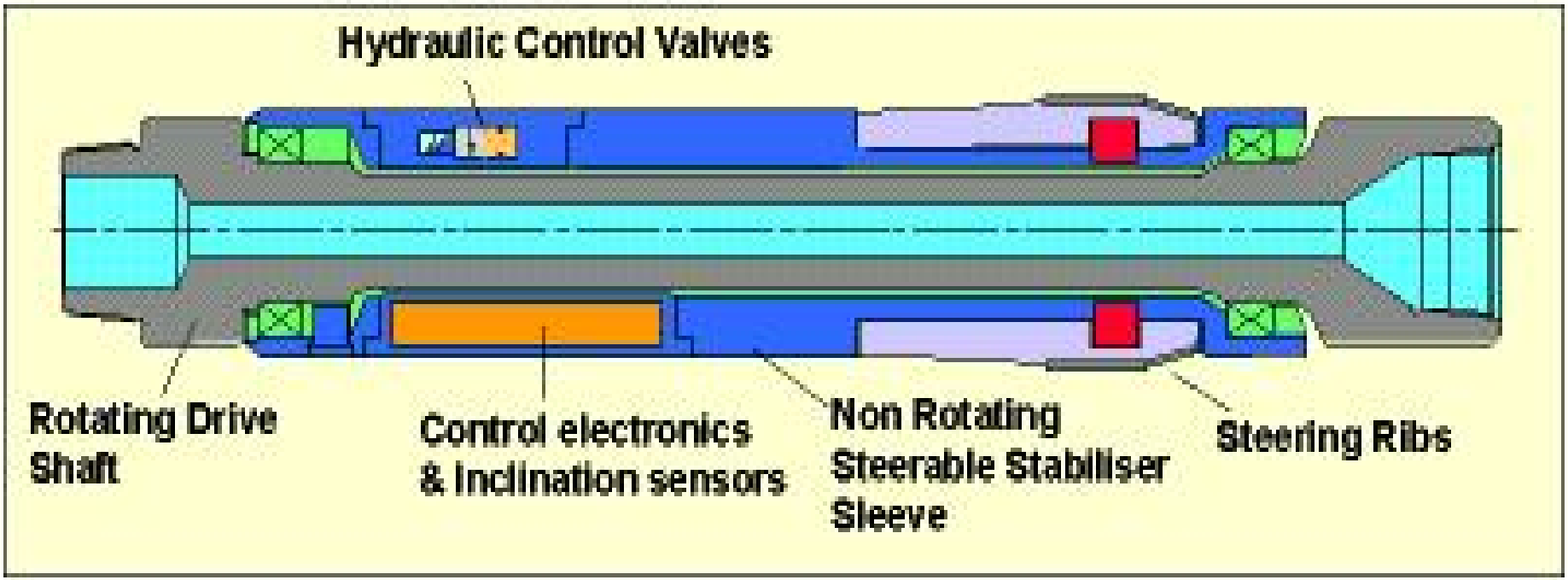
应用实例

A top inter-connector is available for adding optional LWD measurements.

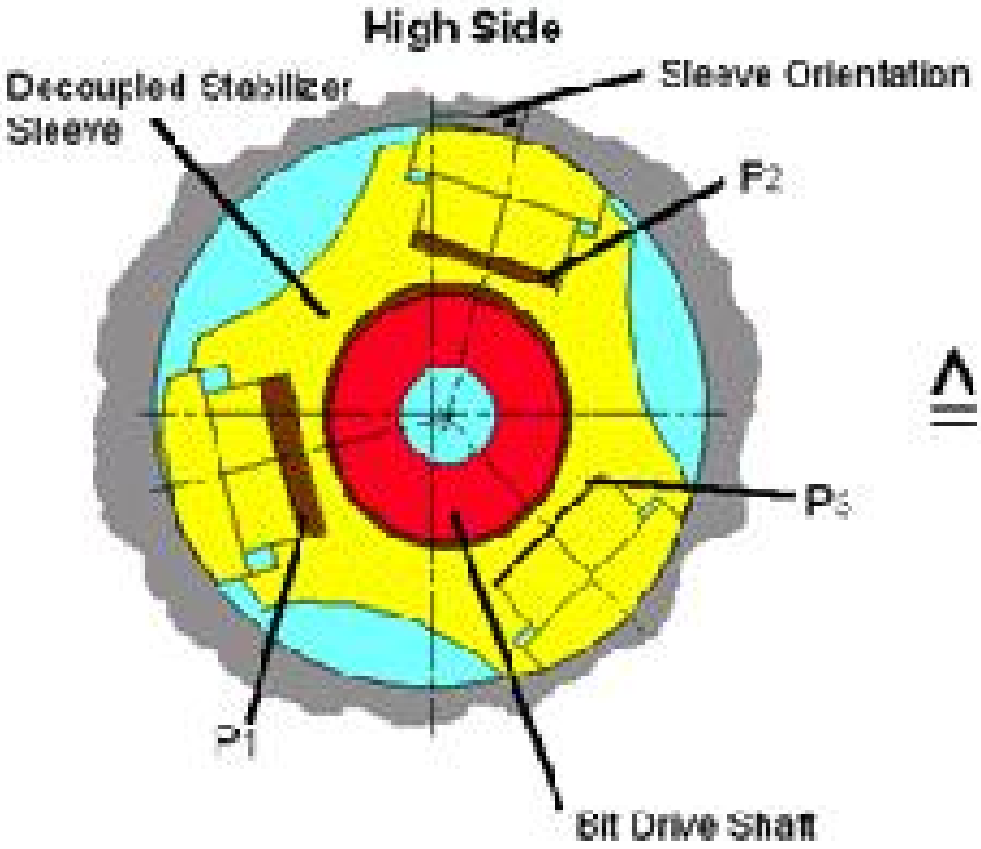


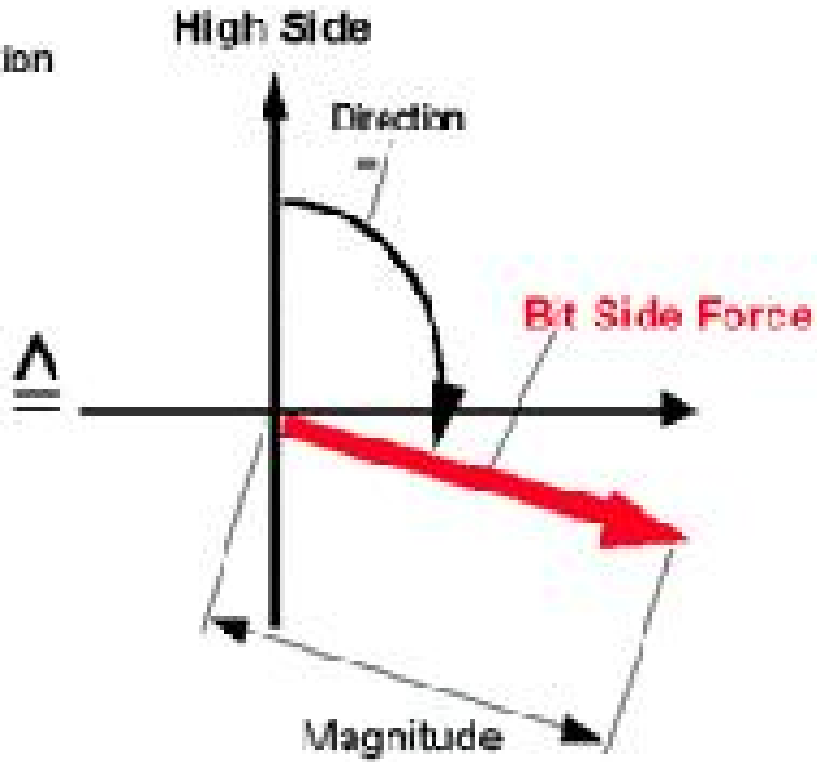
AutoTrak?/sup> RCLS Non-Rotating Steerable Stabilizer

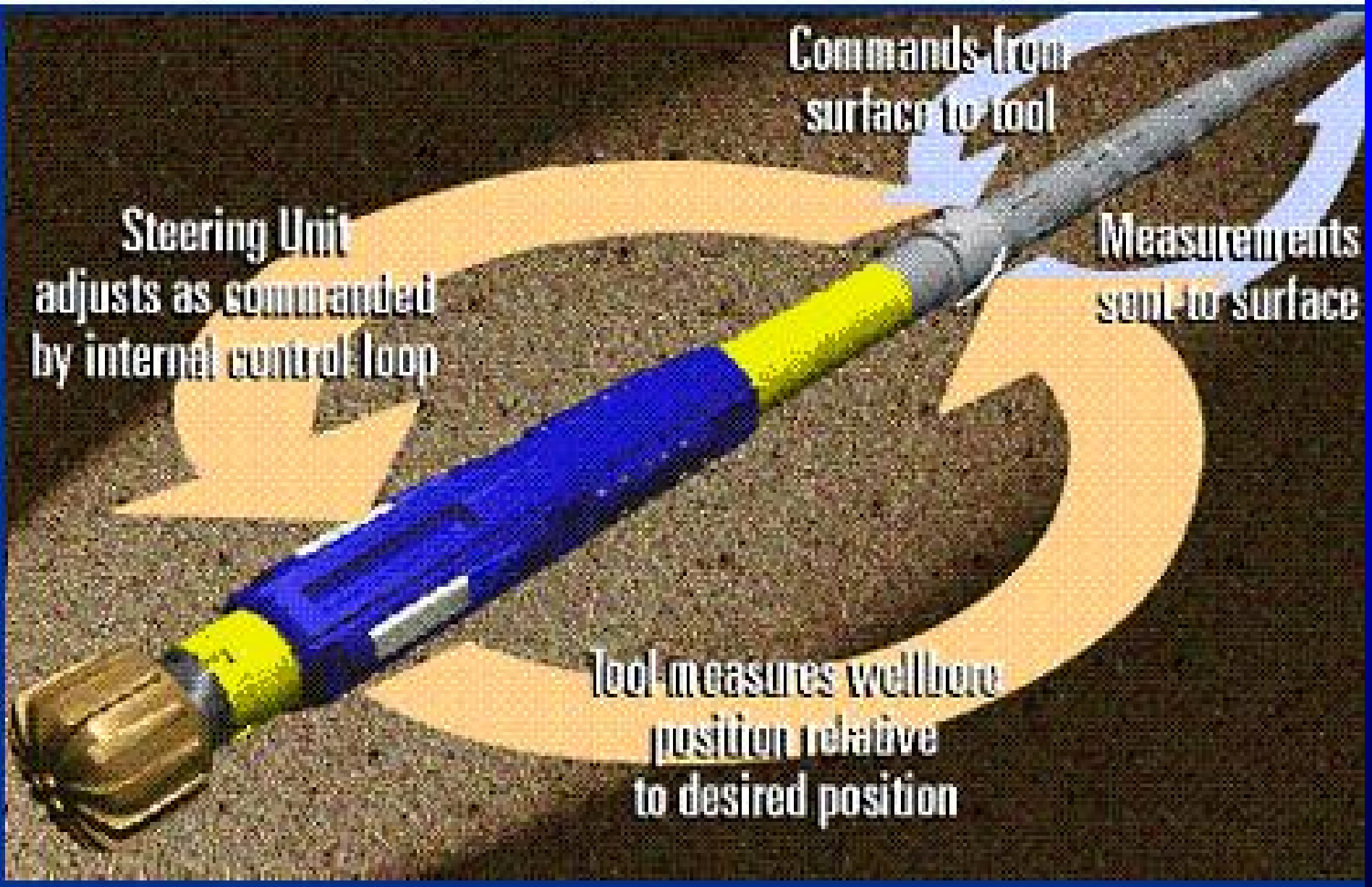




Application of Bit Side Force






Commands from surface to tool
Steering Unit adjusts as commanded by internal control loop
Measurements sent to surface
Tool measures wellbore position relative to desired position

DOWN LOAD DATA



A new Ethernet communication protocal allows rigsite personnel to download the OnTrak memory data at a rate 50 times faster than with previous MWD tools.

What Is The AutoTrak System?

- **The AutoTrak** Rotary Closed Loop Drilling System is an integrated Drilling and Formation Evaluation MWD system that provides precise directional control with continuous drill string rotation.

- The AutoTrak RCLS greatly improves performance and hole quality in directional wells, especially in Rsservoir Navigation, extended reach and designer profile applications.

What Is The AutoTrak System?

- **The AutoTrak RCLS can steer in any desired direction as the drill string rotates.**
- **This increases rates of penetration, reduces torque and drag, and improves well bore quality.**
- **The tool downhole guidance system automatically keeps the hole on the programmed course. Well trajectory changes are communicated to the tool from surface using mud pulse telemetry**
- **This process, known as downlinking, assures accurate well positioning while optimizing overall drilling performance.**



What Is The AutoTrak System?

- **The AutoTrak RCLS combines the benefits of a new steerable Rotary Closed Loop drilling System (RCLS) with recent advances in MWD technology.**
- **The system includes multiple propagation Resistivity()MPR, dual azimuthal gamma ray, directional and near bit inclination measurements. So AutoTrak RCLS can achieve superior directional control and precise wellbore placement to meet both geologic and geometric objectives.**

What Is The AutoTrak System?

- Bi-directional Communications and Power Module INTEQ design engineers have separated the AutoTrak system power and communication module, the Bi-directional Communications and Power Module (BCPM), from the OnTrak?measurement sub to improve system reliability and BHA configuration flexibility.
- Downlink communication system does not disrupt drilling ?allowing us to match changes in the downhole environment by reprogramming the system "on the fly" to optimize wellbore placement, ROP, data rates and telemetry formats.



HOW AUTOTRAK WORKS

- Pistons operated by high pressure hydraulic fluid exert controlled
- AutoTrak RCLS' internal micro-processing system calculates how much pressure has to be applied to each piston to obtain the desired toolface orientation.
- The resulting force vector directs the assembly along the desired trajectory.
- In determining the magnitude of the force applied to the steering ribs, the system also takes into account the dogleg limits for the current hole selection.



Non-Rotating Steerable Stabilizer

- The bit drive shaft rotates through the non- rotating, steerable stabilizer sleeve, which is decoupled from drillstring rotation.
- The stabilizer sleeve contains the near-bit inclinometer, the steering control electronics, and the hydraulic rib control valves.



CASE HISTORIES

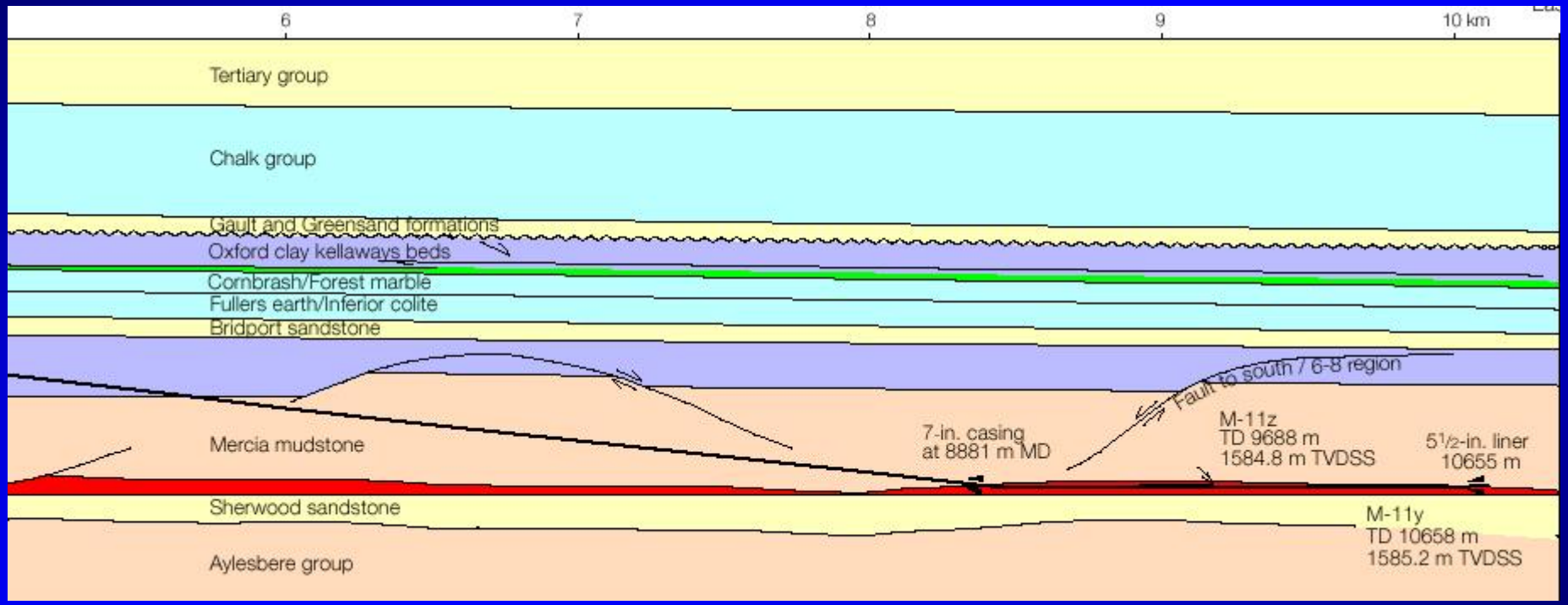
- BP Foinaven W41 - West of Shetland, UK
- Harding A-25 - North Sea, UK
- Harding Field IC4 - North Sea, UK
- Harding Field IC5 - North Sea, UK
- Harding Field PNE-1 - North Sea, UK
- Mahogany MA12B02 - Trinidad, Caribbean
- Miller Well A23 - North Sea, UK
- Mirren Well 22/25b-7 - North Sea, UK
- 204/20 C16 - Schiehallion, UK
- 204/20-C17 - Schiehallion, UK
- Transocean 204/20 C13 - Schiehallion, UK
- Valhall F9A - Norway
- Valhall Hole Enlargement - Norway

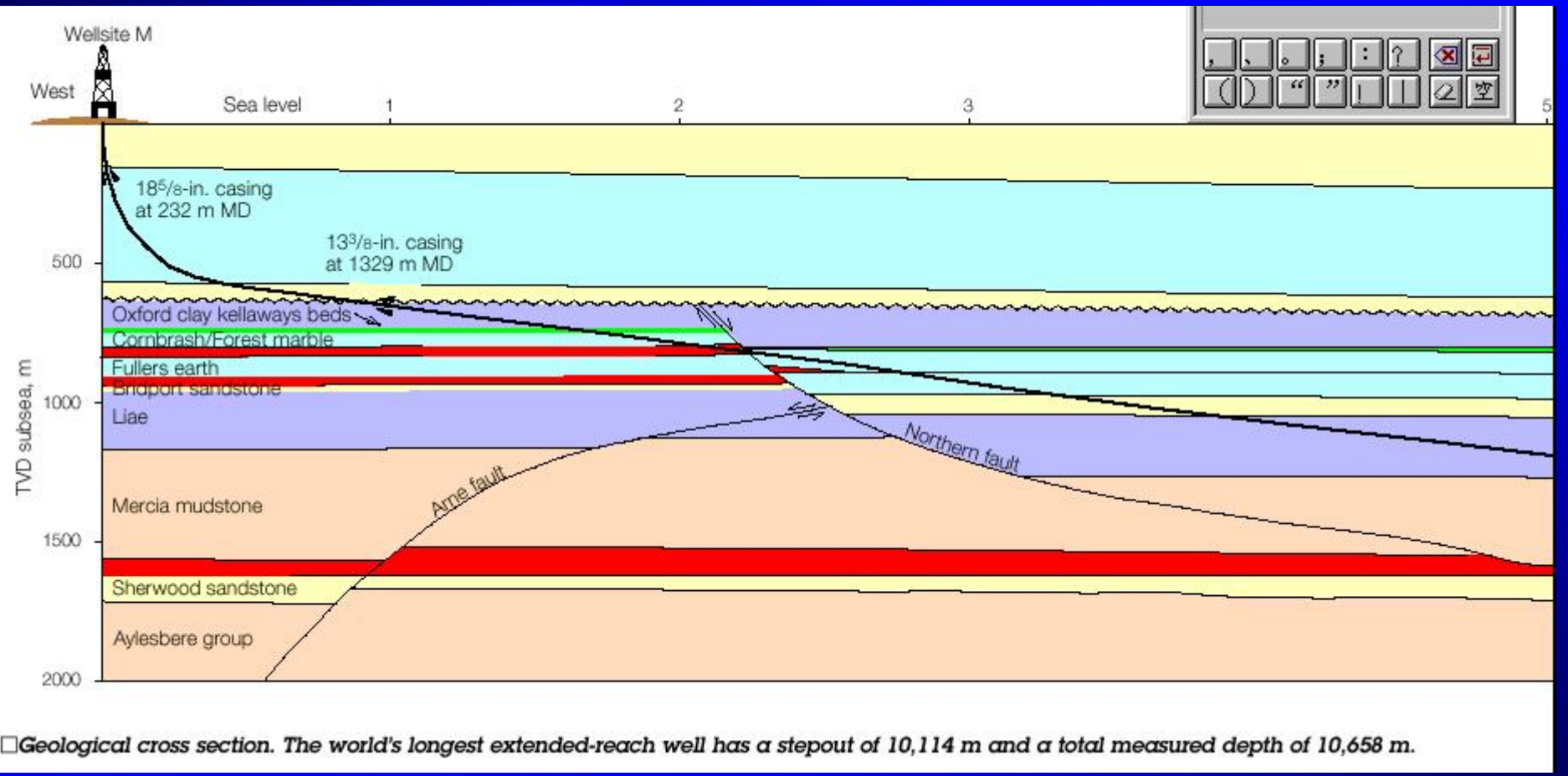
CASE HISTORIES

- Britannia Field 15/30-M9 North Sea, UK
- CACT Consortium (CNOOC/Agip/Chevron/Texaco) HZ21-1-7-T6 - China
- Britannia Operator Limited HZ32-2-9 - China
- ChevronTexaco
- Green Canyon Deepwater, Gulf of Mexico
- Gulf of Mexico
- North Platform, Alba North, UK
- North Platform, Well A36, Alba North, UK
- North Platform, Well A37, Alba North, UK
- North Platform, Well A38, Alba North, UK
- North Platform, Well A41, Alba North, UK
- SL 340 - Blanche Bay, Gulf of Mexico

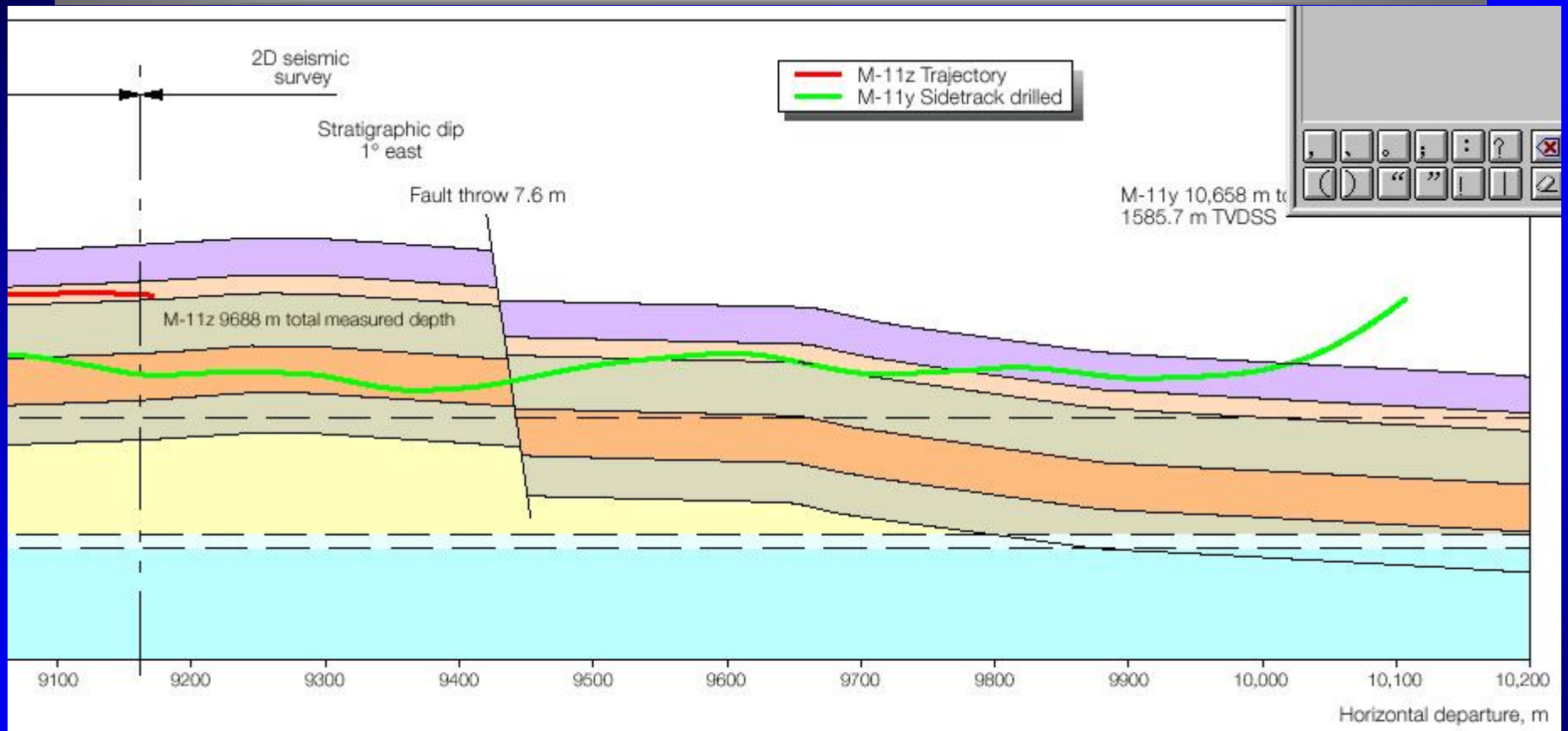
CASE HISTORIES

- SL 340 - Blanche Bay, Gulf of Mexico
- Conoco
- 15/23B-13 - Kappa, UK
- 15/24B-W6 - MacCulloch, UK
- 15/24B-W6 - MacCulloch, UK
- CNOOC
- SZ36-1-CF-1 - China, Bohai
- Enterprise
- Bijupira Field - BJ-Q, Brazil
- Bijupira Field - BJ-T, Brazil
- Bijupira Field - BJ-T Main, Brazil
- Bijupira Field - BJ-Ux, Brazil
-

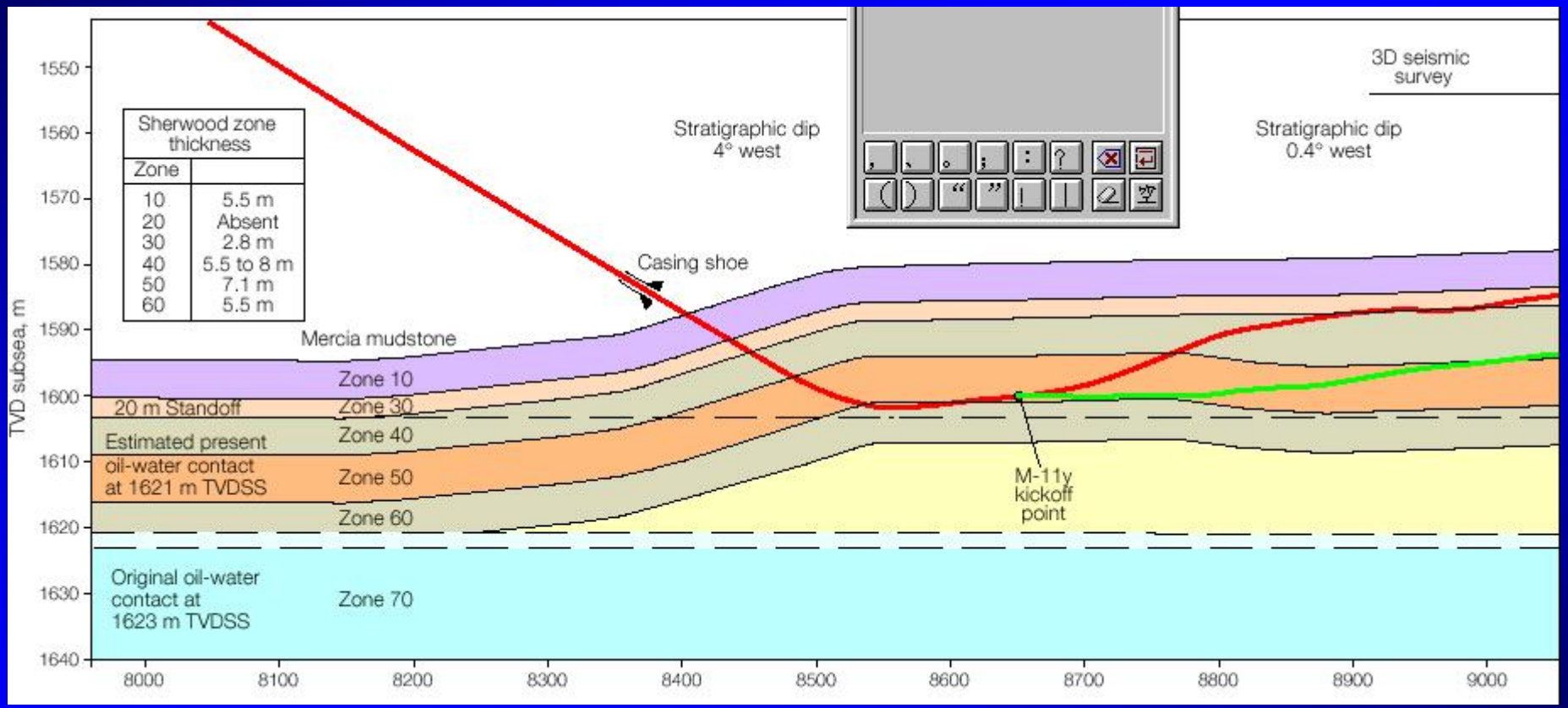

6
7
8
9
10 km
Tertiary group
Chalk group
Gault and Greensand formations
Oxford clay kellaways beds
Cornbrash/Forest marble
Fullers earth/Inferior colite
Bridport sandstone
Mercia mudstone
Sherwood sandstone
Aylesbere group
Fault to south / 6-8 region
7-in. casing
at 8881 m MD
M-11z
TD 9688 m
1584.8 m TVDSS
5½-in. liner
10655 m
M-11y
TD 10658 m
1585.2 m TVDSS



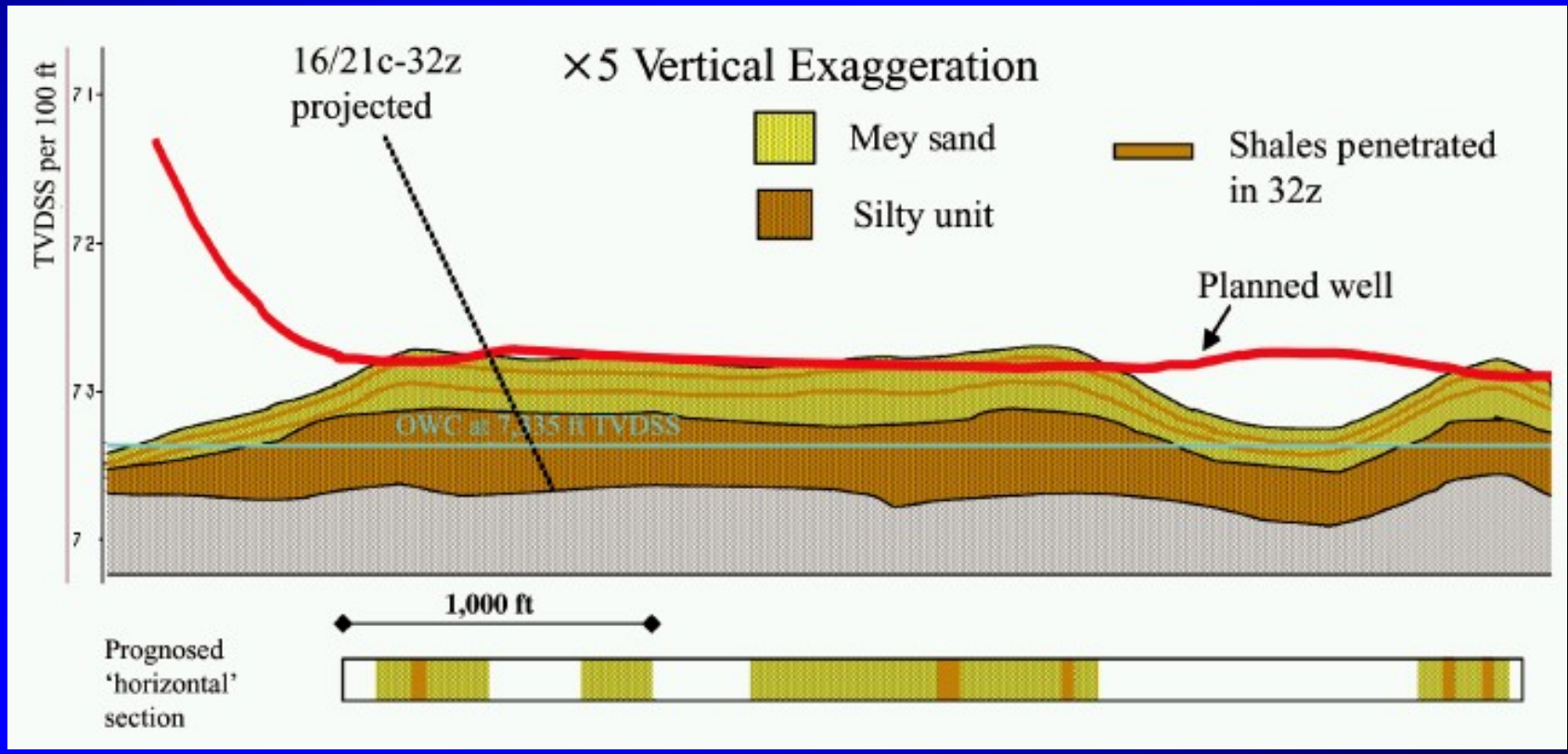
Geological cross section. The world's longest extended-reach well has a stepout of 10,114 m and a total measured depth of 10,658 m.

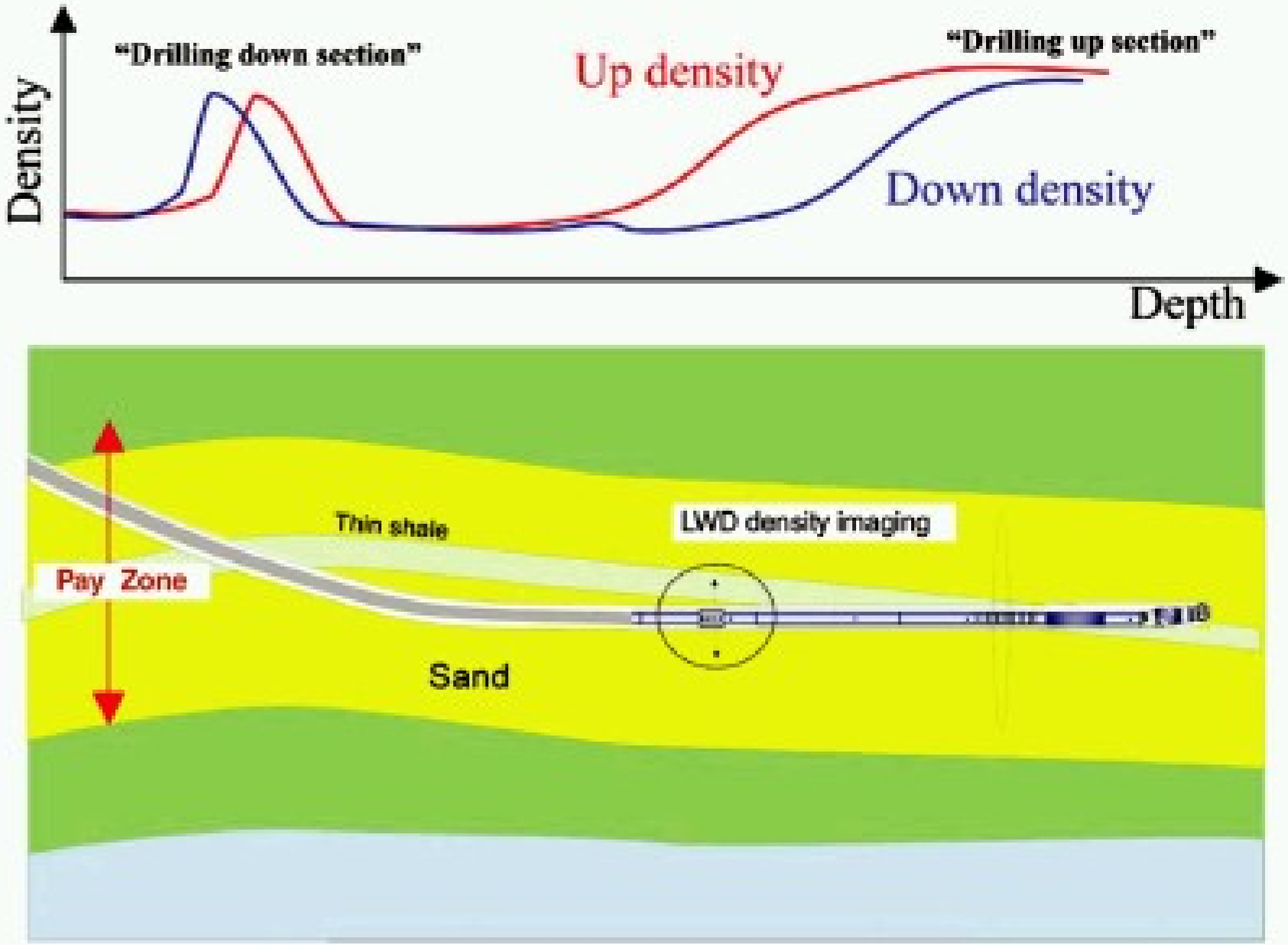


Sidetrack cross section. When the original borehole (M-11z) reached 9 km, the well was sidetracked to access a better part of the reservoir. The sidetracked lower bore (M-11y) was cased and completed, and the upper borehole left open. The tip of the well veers upward to stay away from the oil-water contact and to penetrate additional formation layers for added geological information.

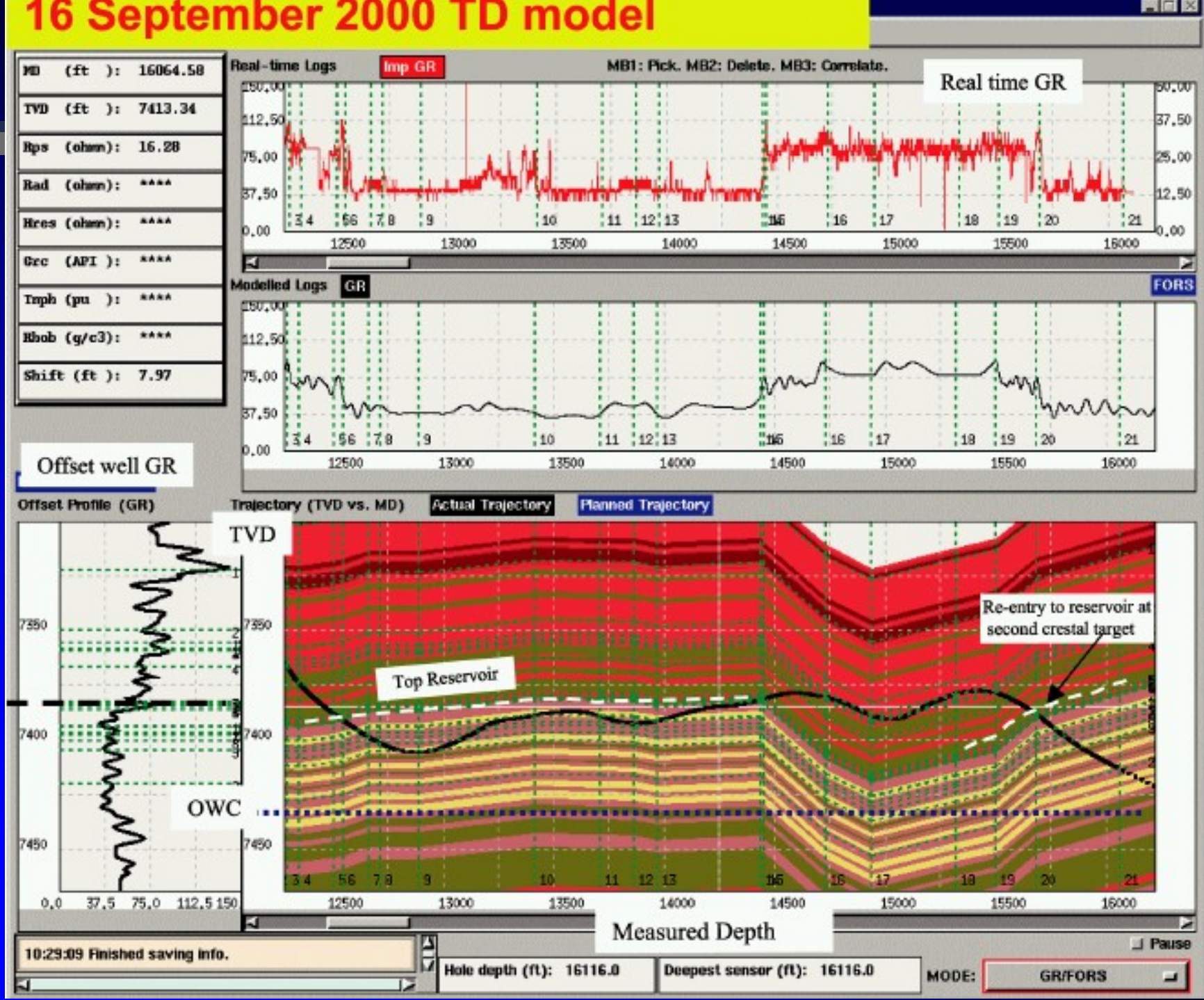

Sherwood zone thickness
Zone
10 5.5 m
20 Absent
30 2.8 m
40 5.5 to 8 m
50 7.1 m
60 5.5 m
Stratigraphic dip 4° west
Stratigraphic dip 0.4° west
3D seismic survey
Casing shoe
Mercia mudstone
Zone 10
20 m Standoff
Zone 30
Zone 40
Estimated present oil-water contact at 1621 m TVDSS
Zone 50
Zone 60
M-11y kickoff point
Original oil-water contact at 1623 m TVDSS
Zone 70
TVD subsea, m
1550
1560
1570
1580
1590
1600
1610
1620
1630
1640
8000
8100
8200
8300
8400
8500
8600
8700
8800
8900
9000

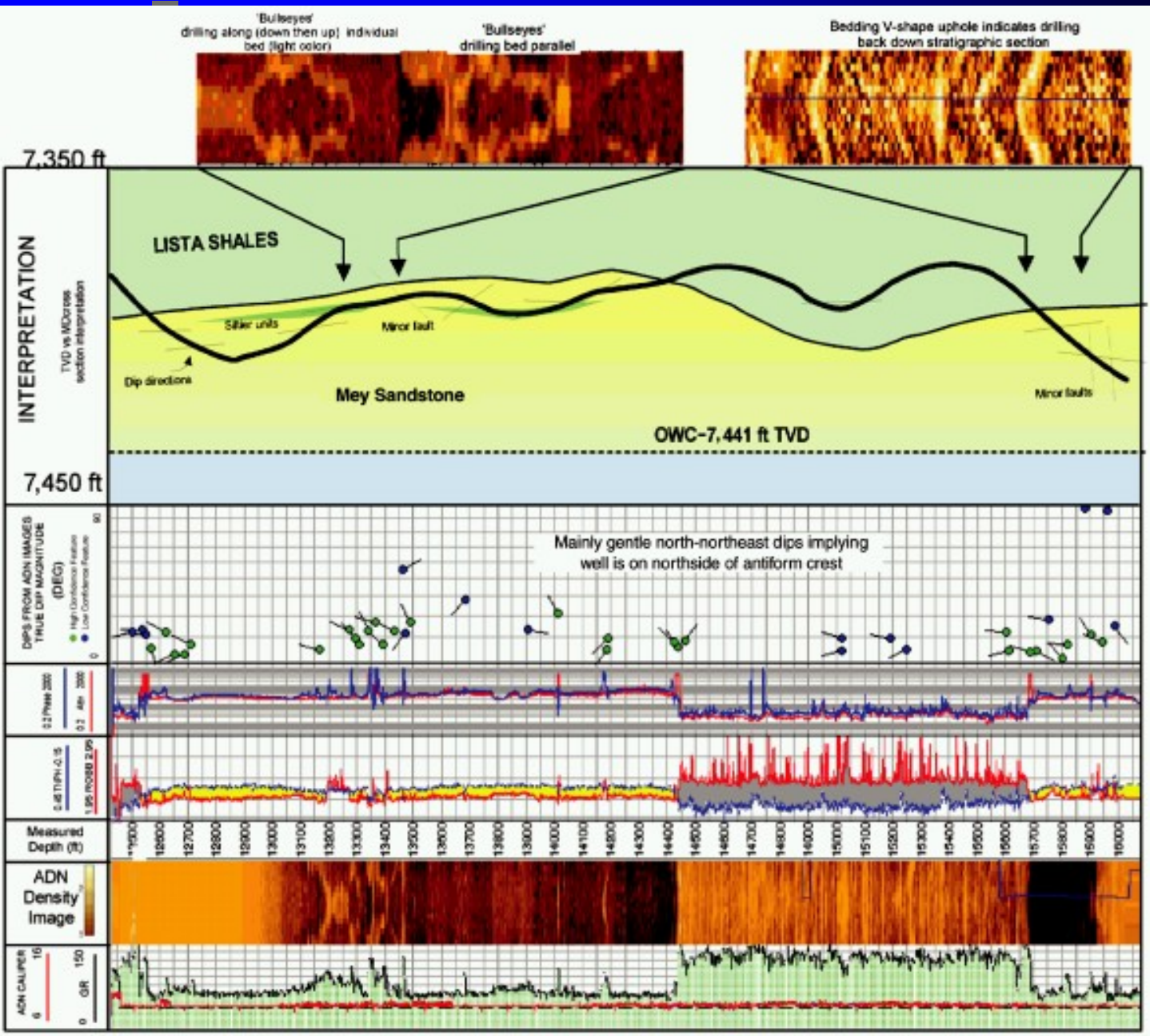
Precise Well Placement With Rotary Steerable Systems and Logging-While-Drilling Measurements （Geosteering tool）




"Drilling down section"
Up density
"Drilling up section"
Density
Down density
Depth
Thin shale
LWD density imaging
Pay Zone
Sand

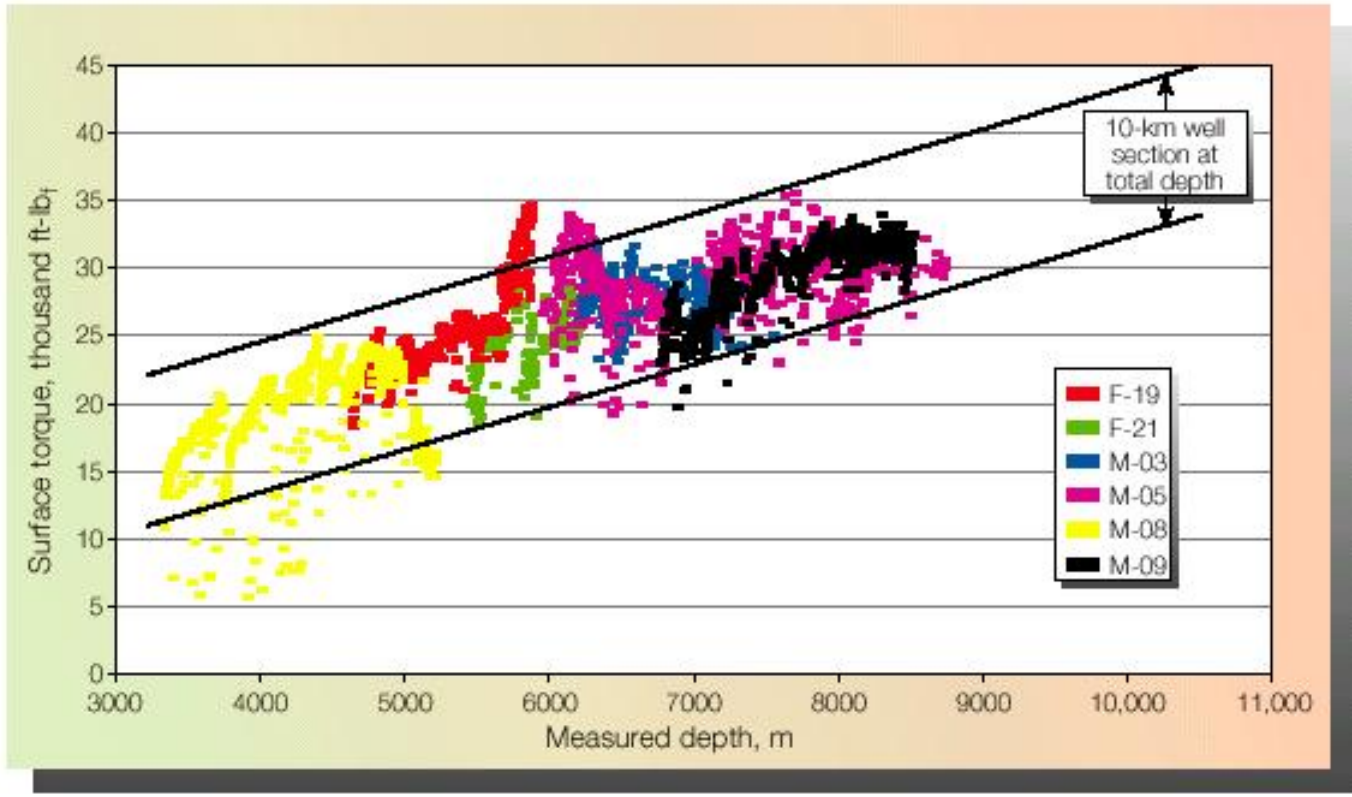
16 September 2000 TD model



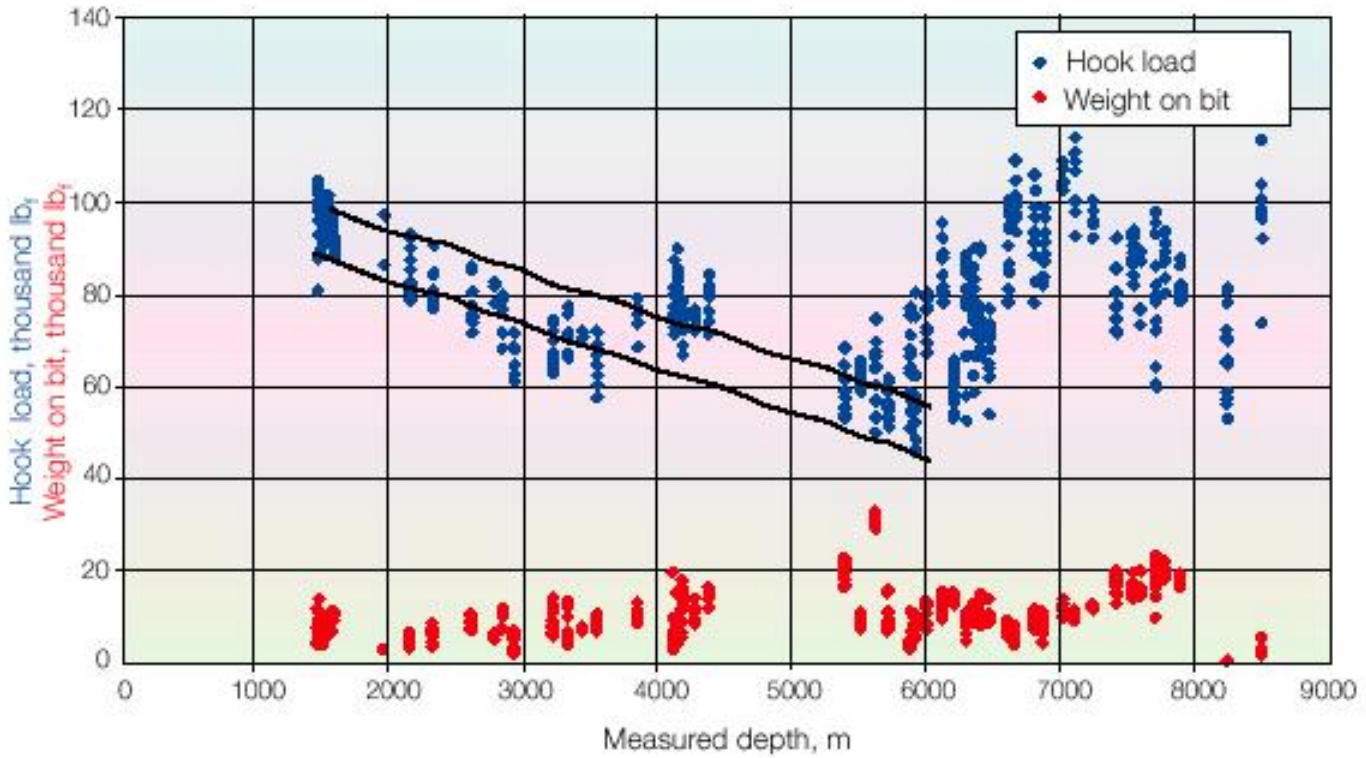

'Bullseyes' drilling along (down then up) individual bed (light color)
'Bullseyes' drilling bed parallel
Bedding V-shape uphole indicates drilling back down stratigraphic section
7,350 ft
INTERPRETATION
TVD vs MDcross section interpretation
LISTA SHALES
Silter units
Minor fault
Dip directions
Mey Sandstone
Minor faults
OWC-7,441 ft TVD
7,450 ft
DIPS FROM ADN IMAGES TRUE DIP MAGNITUDE (DEG)
High Confidence Feature
Low Confidence Feature
Mainly gentle north-northeast dips implying well is on northside of antiform crest
Measured Depth (ft)
ADN Density Image
ADN CALIPER
GR

摩阻扭矩预测与分析

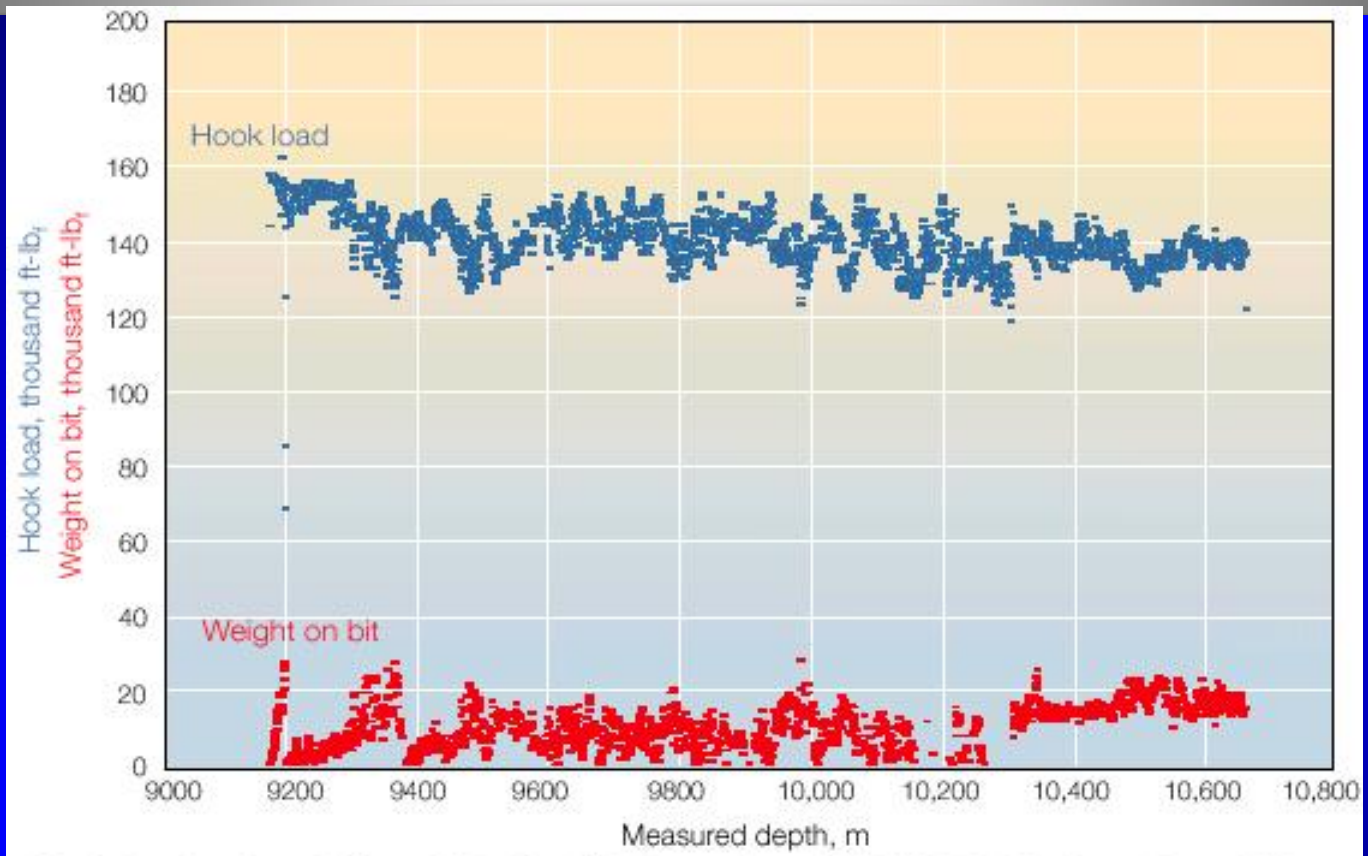
- 摩阻扭矩分析的力学模型
  - 刚杆模型
  - 软杆模型
- 钻柱的屈曲分析
- 摩擦系数的确定



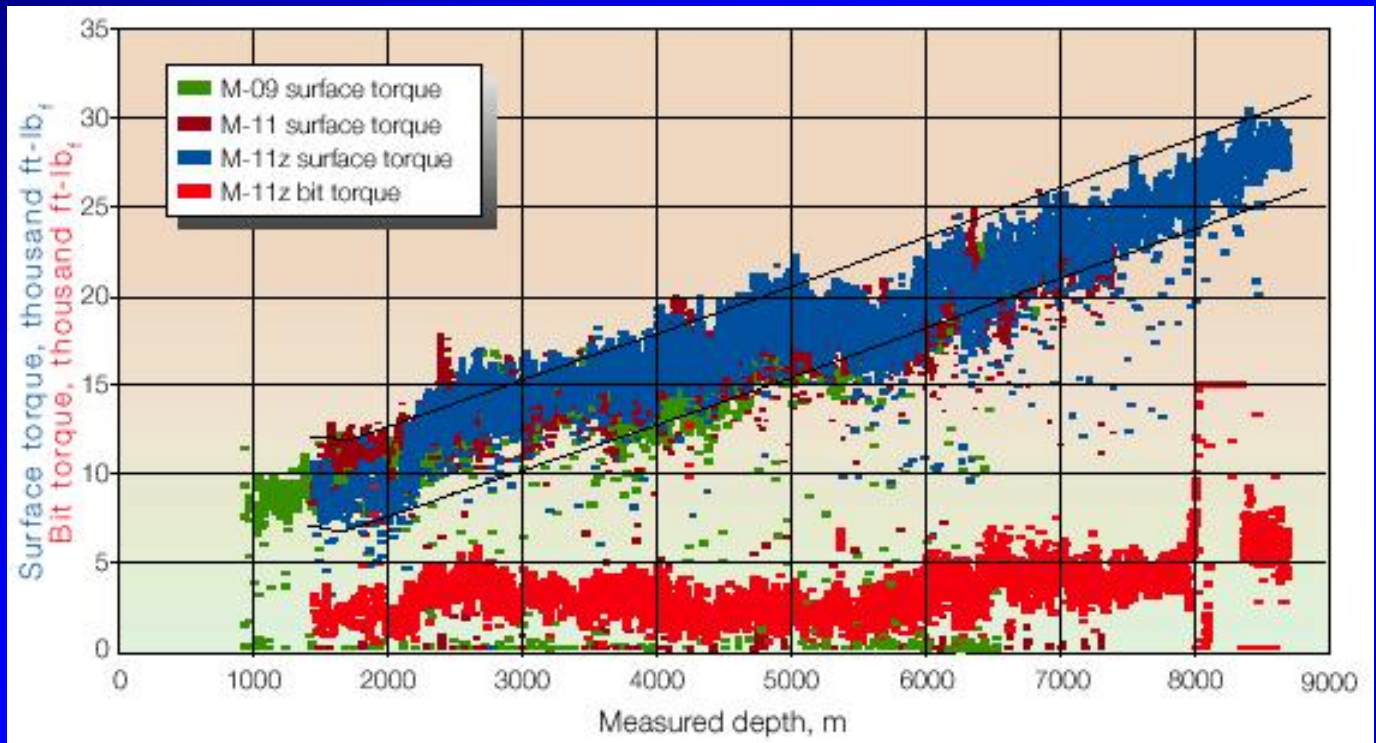
Surface torque during reservoir drilling. Modeling the actual surface torque in the 8 1/2-in. sections of offset wells produced reasonable estimates of the expected torque at 10-km. The predicted torque range at 10 km reaches the upper limit of the top-drive capacity.



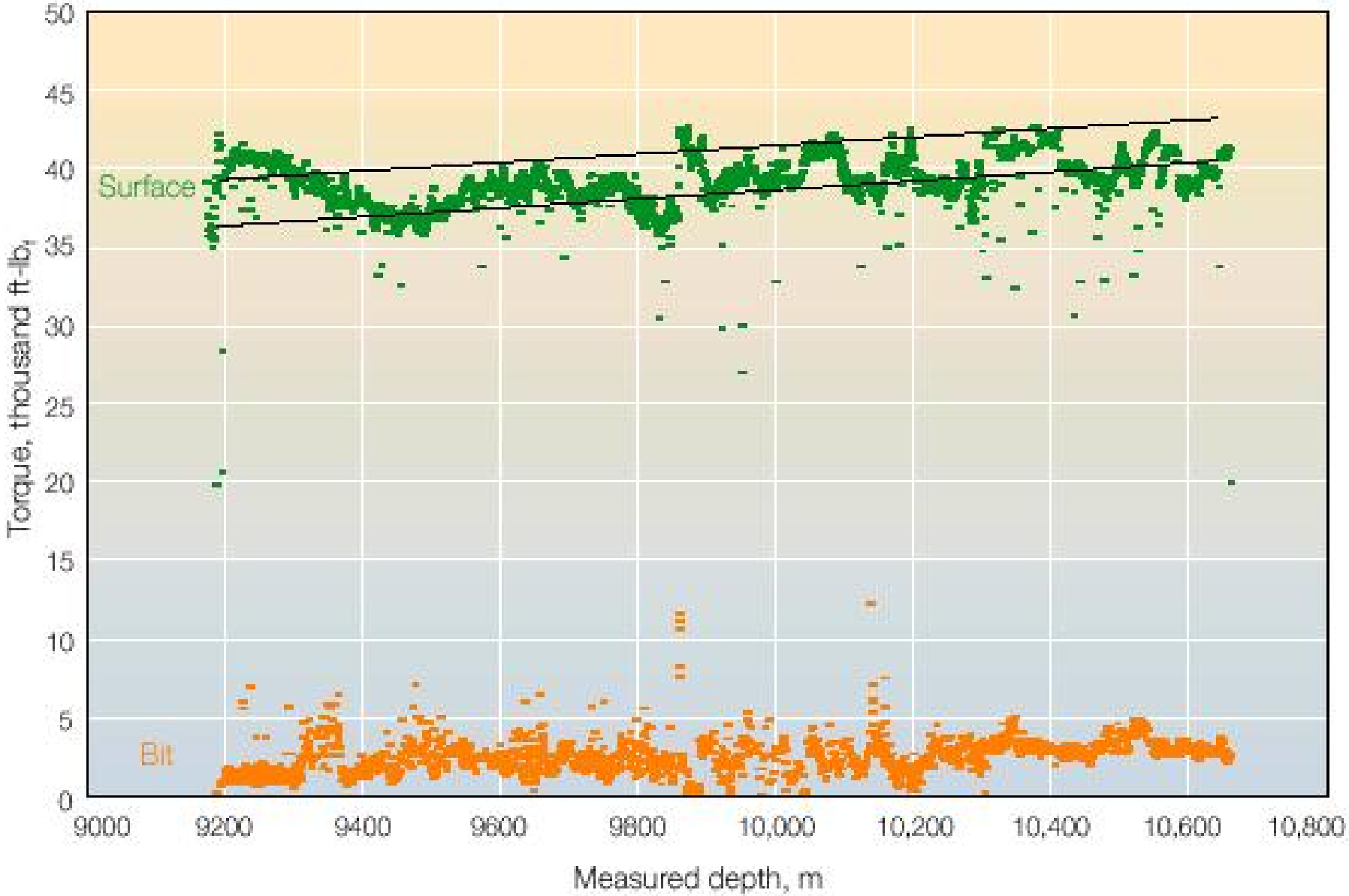
Hook load during slide drilling the 12 1/4-in. section of Well M-11. The hook load during slide drilling followed the expected trend (parallel black lines) down to 6000 m measured depth. After this depth, there was considerable gain in hook load. Beyond 8000 m, applying weight on bit during slide drilling was difficult, if not impossible. Drilling past this measured depth therefore required rotation to overcome friction and allow weight to be transferred to the bit.



Hook load and weight on bit in the 8 1/2-in. section of Well M-11. During rotary drilling the 8 1/2-in. section, the hook load decreased slightly while still maintaining effective weight on bit. Rotating the pipe lowered friction factors and helped keep the hole clean to allow successful drilling past 10 km.

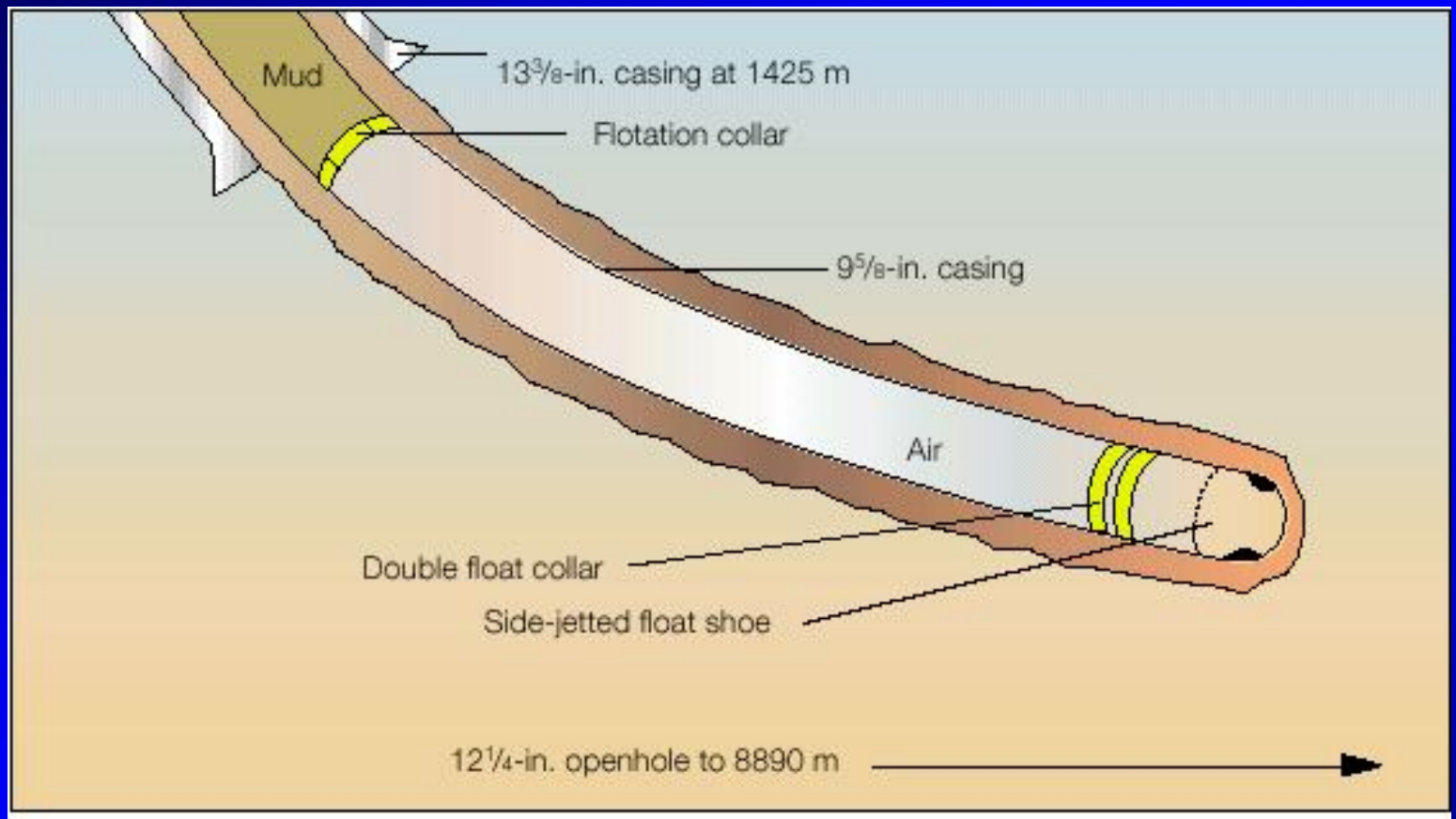


Torque during rotary drilling of the 12¼-in. section of Well M-11. The parallel lines indicate the torque trend predicted for the M-11 12¼-in. section. The recorded surface torque matched the prediction quite accurately.



Torque in the 8 1/2-in. section of Well M-11. Bit torque remained relatively stable throughout the 8 1/2-in. reservoir section. The surface torque showed some fluctuation but remained within the range predicted (parallel black lines) by torque and drag simulators.

漂浮下套管技术



Partially floated 9⅝-in. casing. Casing flotation experiments on Wells M-03, M-08 and M-09 proved the concept for the extreme test in Well M-11. The bottom section of casing, containing air, remained neutrally buoyant to allow the casing to slide more easily along the well path. The mud-filled upper section provided the weight necessary to push the entire string to bottom. Once the casing was landed, pump pressure was applied to shear the plugs in the flotation collars and allow circulation.

分枝井钻井技术

钻井新技术

- 欠平衡钻井技术(Underbalanced Drilling)
  - 定义：指钻井过程井内压力小于地层压力一定值的钻井过程
  - 设备：旋转防喷器、井内流体的地面多级分离器、惰性气体发生器
  - 基本理论：多相流理论
  - 优点：
    - 适合于在异常低压地区钻井
    - 及时发现和保护油气层
    - 提高机械钻速，降低钻井成本
  - 欠平衡图

套管钻井技术

钻井新技术

- 连续油管的应用(Coiled tubing Tech.)
  - 应用：
    - 钻井
    - 完井
    - 修井
  - 理论：
    - 流体力学分析
    - 疲劳寿命估计



Coiled Tubing(reeled tubing)



Coiled Tubing(reeled tubing)





Coiled Tubing(reeled tubing)

- **Applications**
  - Through-tubing re-entry
  - Conventional re-entry
  - Underbalanced drilling
  - Slimhole exploration
- **Operation**
  - Unit is automated and controlled using a PC-based system with a graphical operator interface inside the control cabin.
  - Operated by a multi-task crew
  - On-line directional drilling process

Coiled Tubing(reeled tubing)

- **OPERATION**
  - **Monitoring of tubing fatigue and forces is on-line**
  - **Second generation reel with the automatically Controlled “parabolic loop system” (PLS) significantly extends tubing life.**
  - **BHA, proven in over four years of coiled tubing drilling, has sensors for directional, gamma ray, pressure and weight on bit.**
  - **Process Control Cabin located at workfloor for enhanced monitoring and safety**



钻井新技术

- 保护油气层的钻井完井技术
  - 岩性测定及分析技术
  - 储层敏感性评价技术
  - 有气层损害机理研究
  - 油气层损害评价技术
  - 保护有气层的钻井液完井液技术
  - 保护油气层的固井技术
  - 负压射孔技术
  - 保护油气层的压裂酸化技术