Teknik Pemboran Sumur Geothermal

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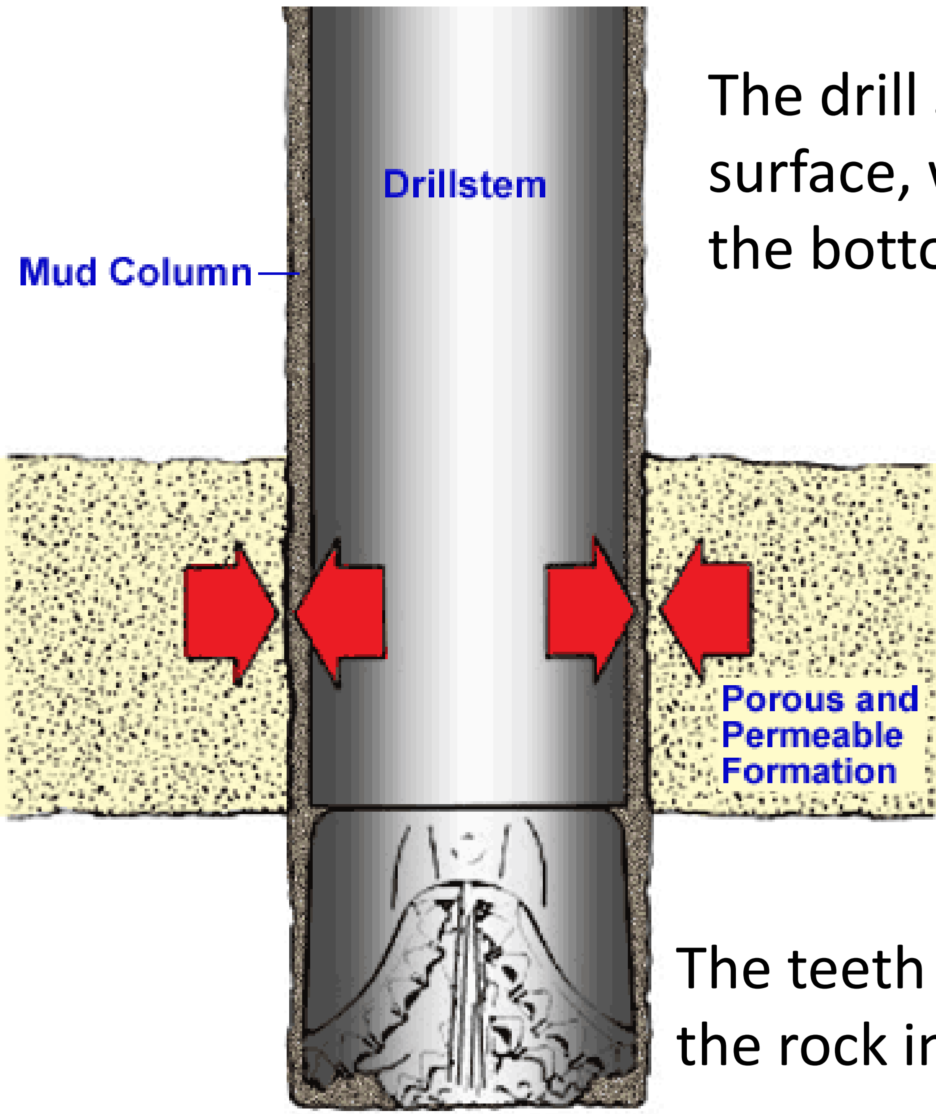
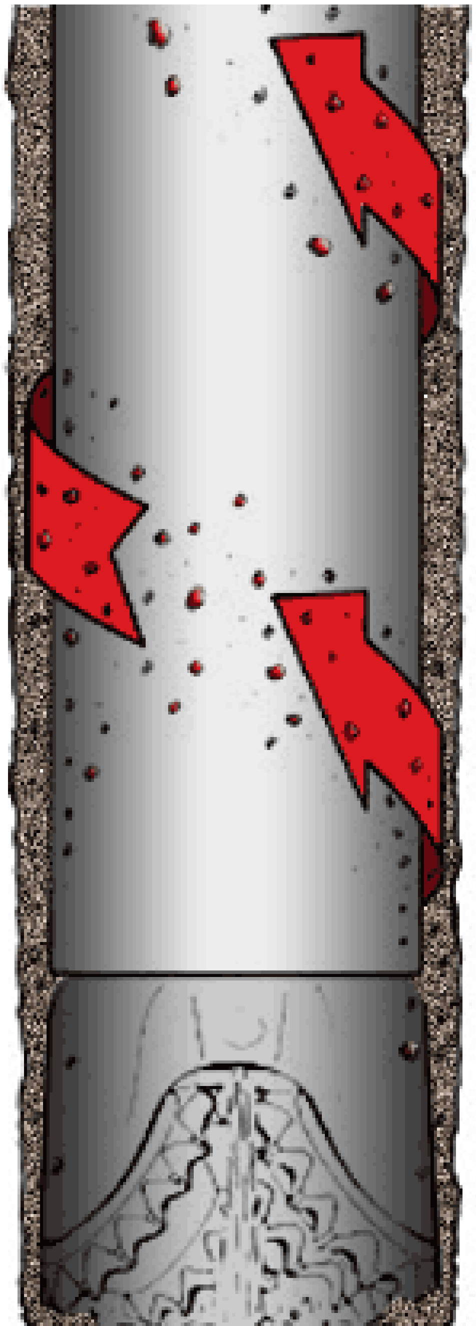


The drill string is turned at surface, which turns the bit at the bottom of the hole.

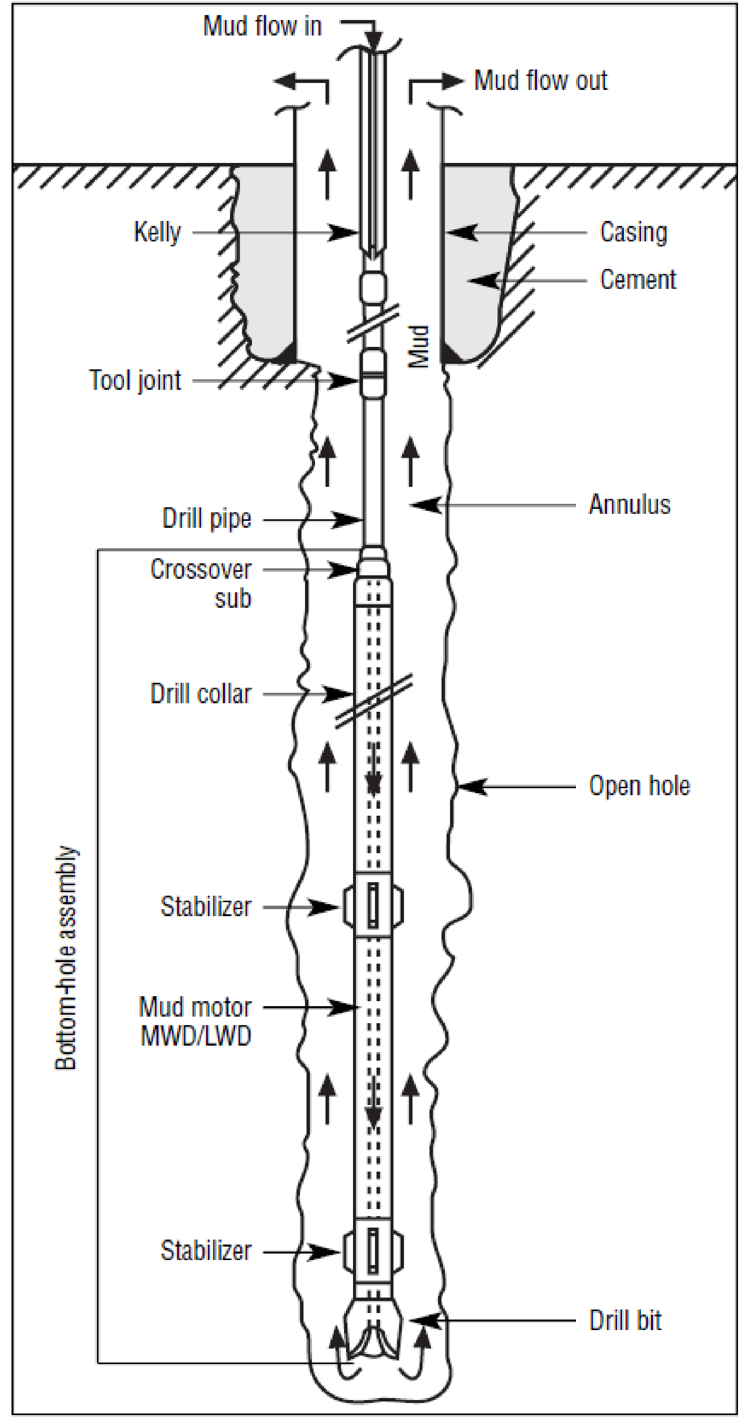
Drilling fluid is pumped down the inside of the drill pipe, through jet nozzles in the bit, and into the “annulus”. This is the space between the sides of the hole and the drill pipe.

The teeth on the drill bit grind the rock into fragments, or “cuttings”.

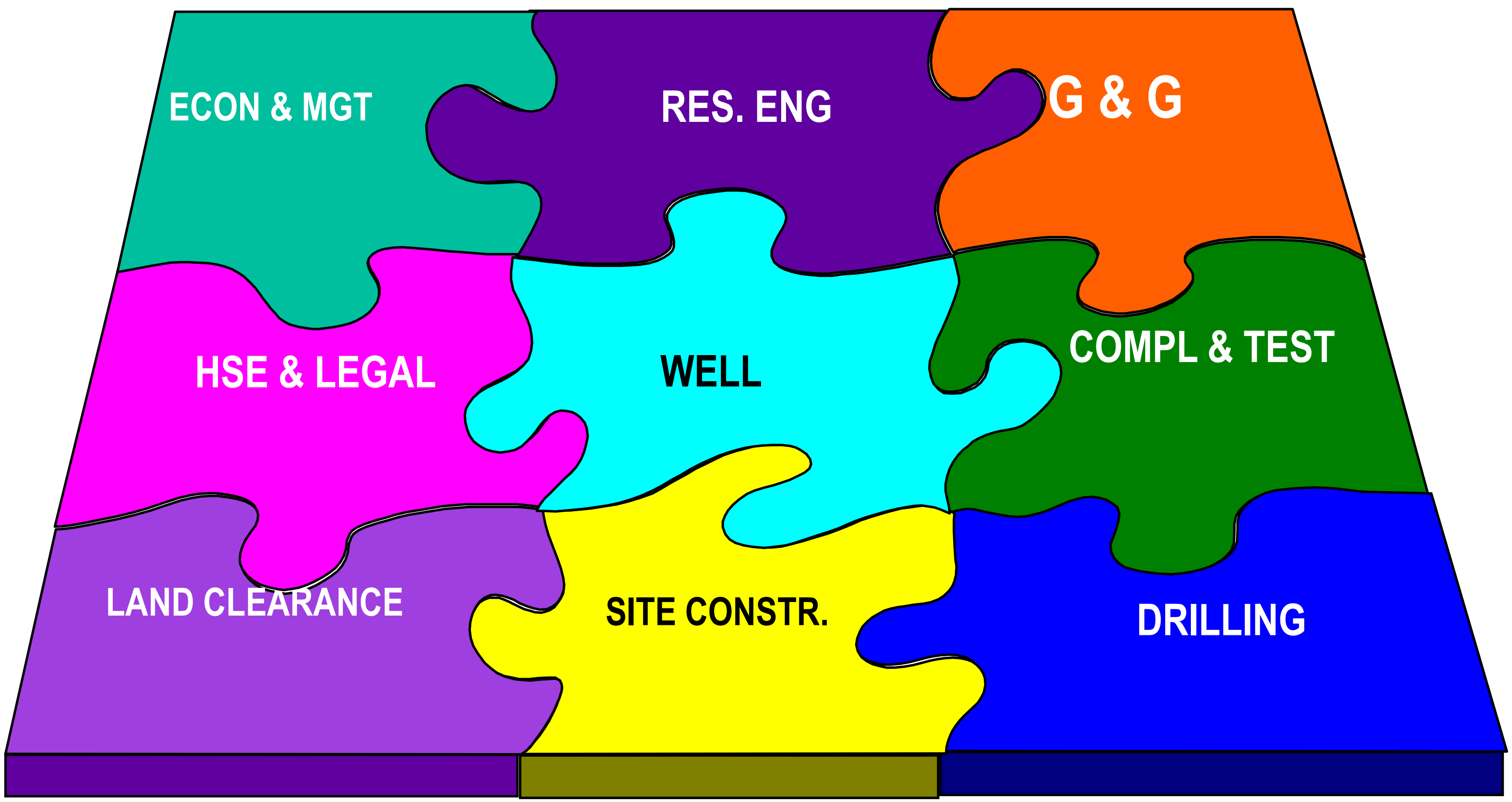


The mud lifts the cuttings and circulates them back to surface where they are removed.

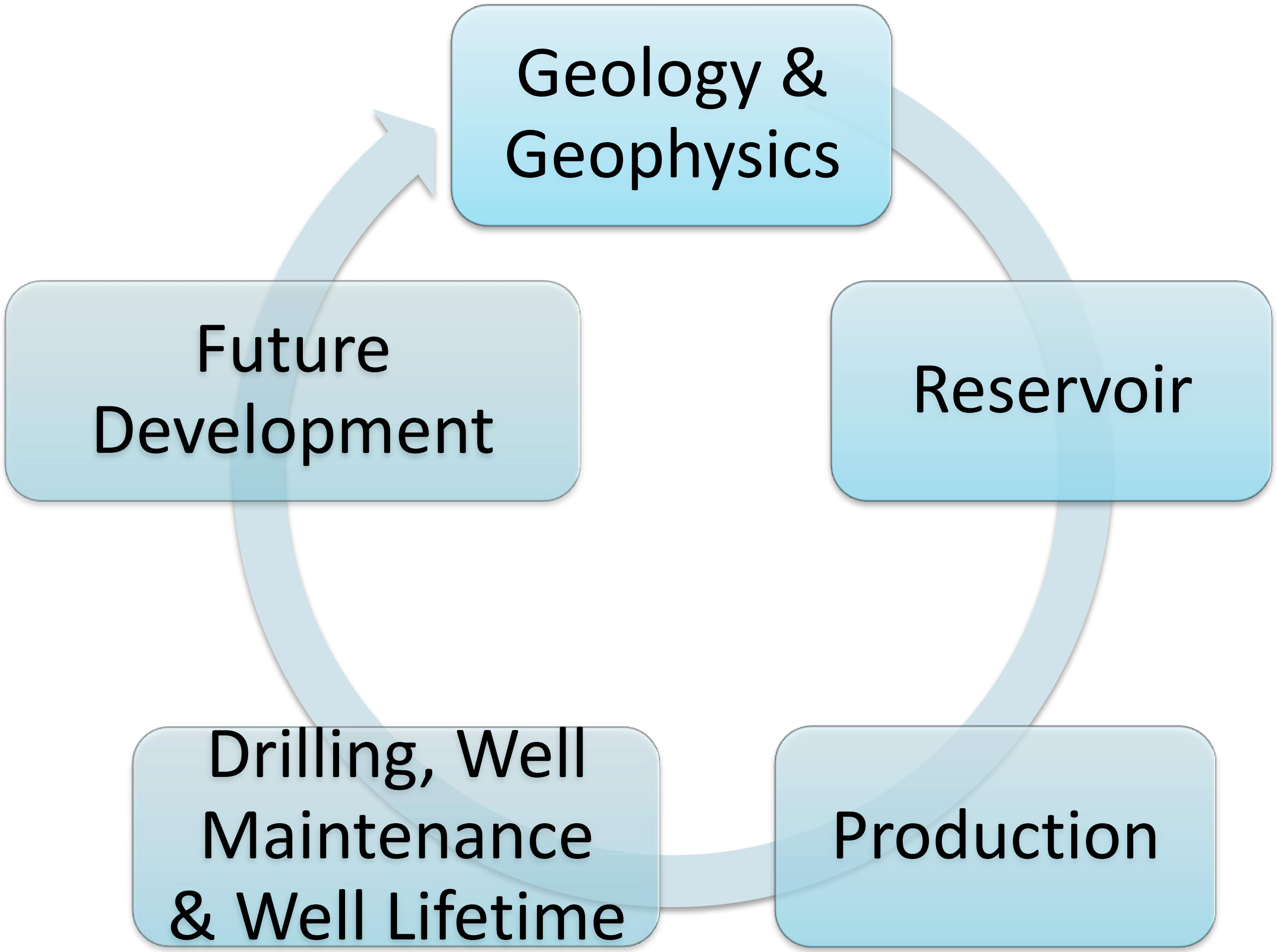
Rotary Drilling – Drillstring components

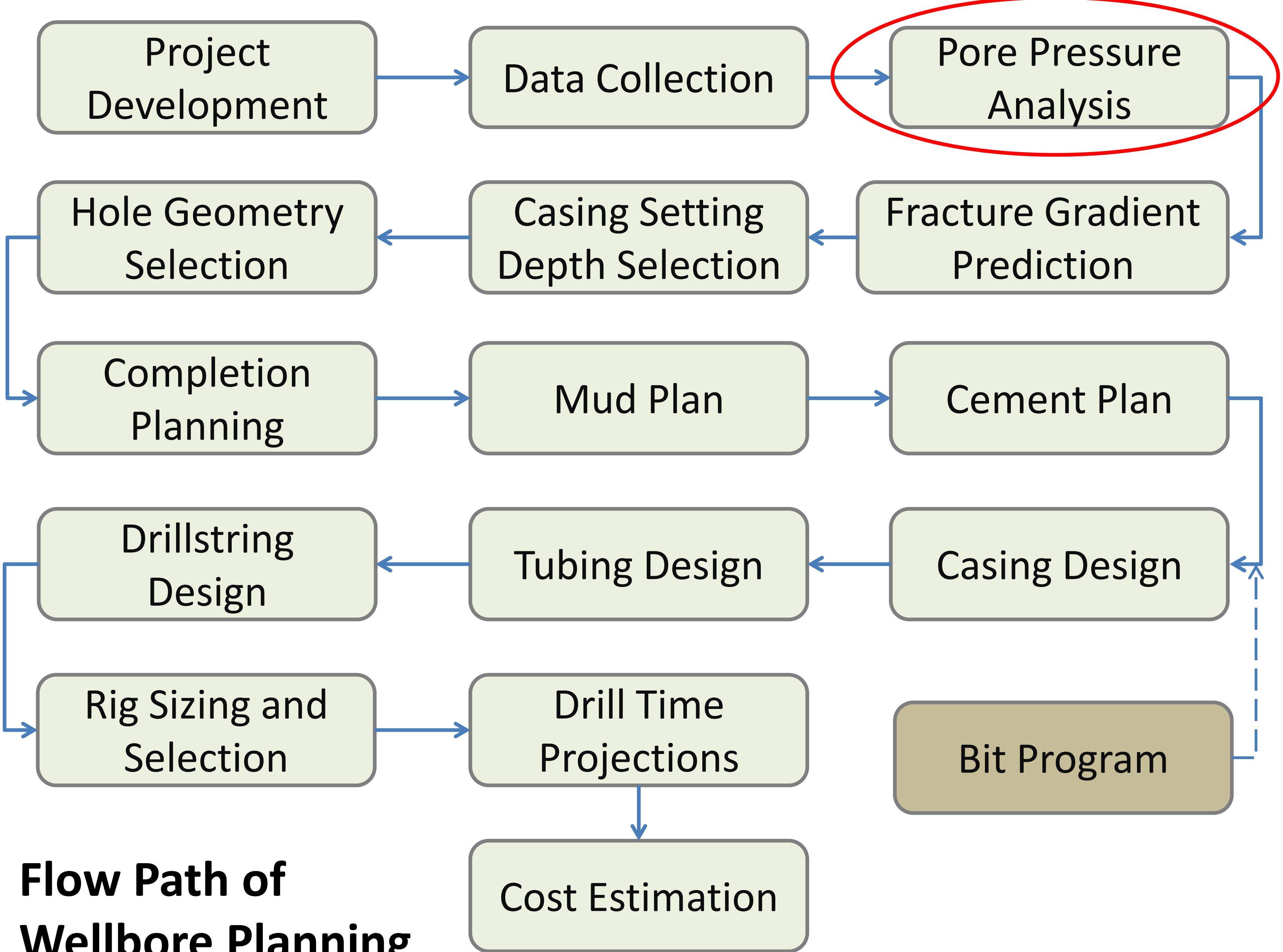


Perspective



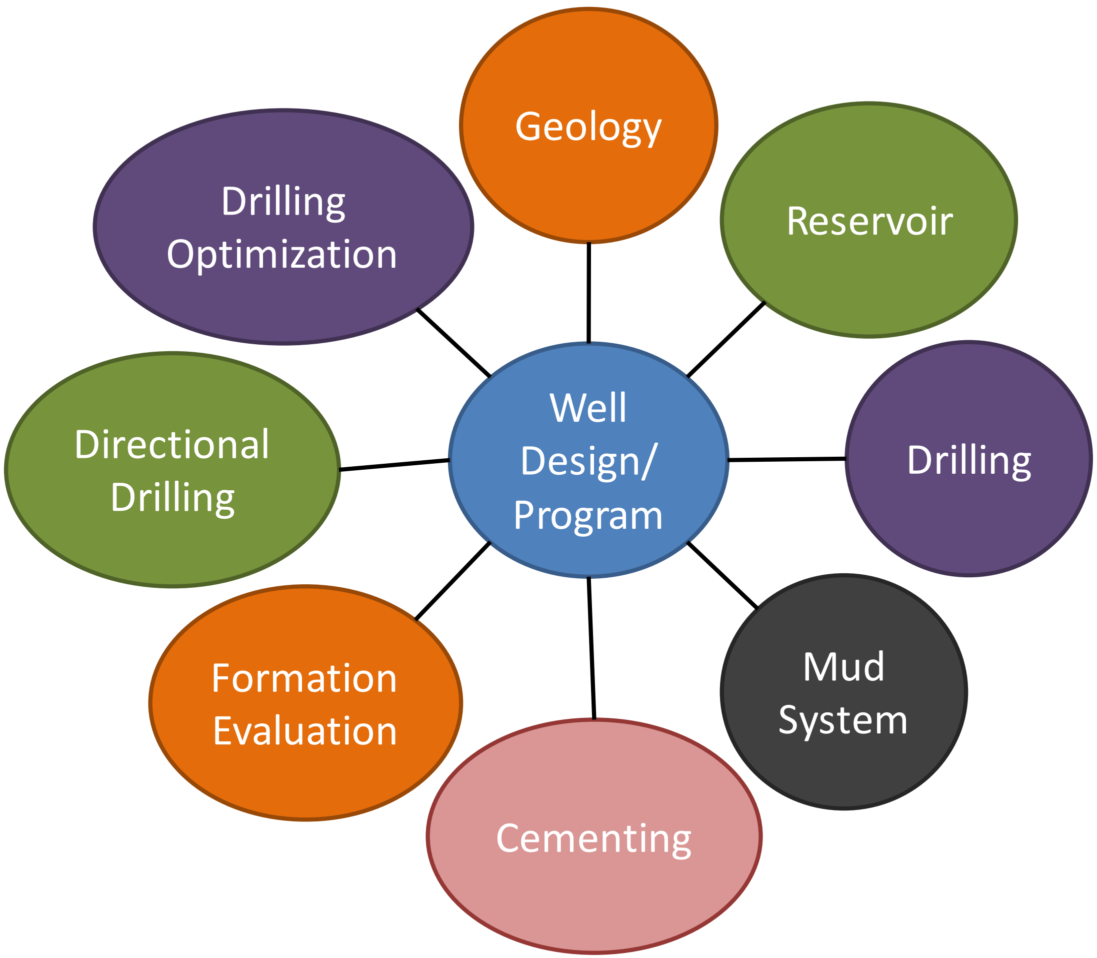
Planning and Evaluation





Flow Path of Wellbore Planning

How we shall act…



DRILLING

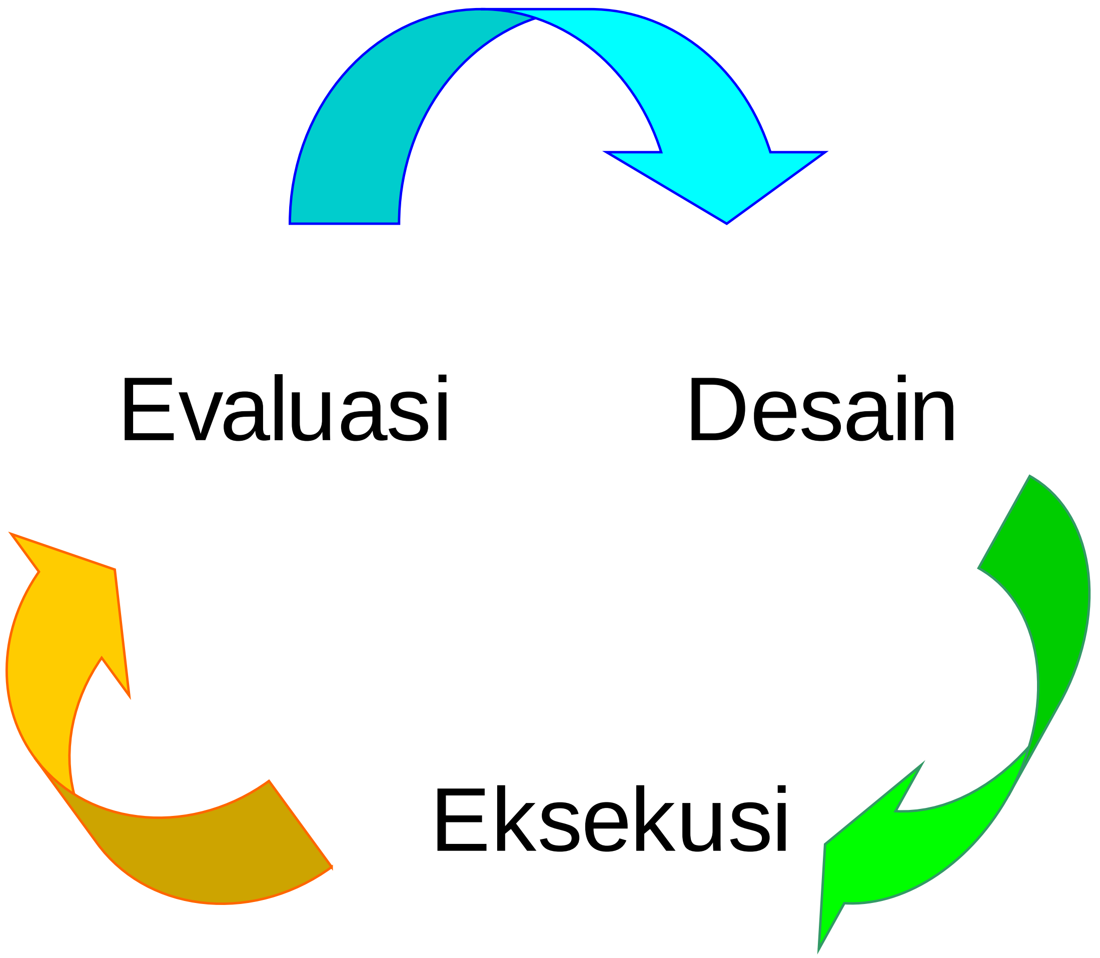
- Memperkirakan biaya pemboran tiap *section*
- Menentukan parameter yang harus ditingkatkan (improvement)
- Memperkirakan biaya total pemboran berdasarkan biaya per hari
- Memperhitungkan waktu *tripping, wiper trips,* dan sirkulasi
- Memperhitungkan waktu *making up* dan *breaking up BHA*
- Memperhitungkan *directional drilling, MWD,* dan *gyro*

CONSUMABLES

- Biaya semen dan waktu penyemenan
- Biaya casing dan perlengkapannya
- Biaya komplesi
- Fluida komplesi dan pemboran
- Memperkirakan semua kondisi di atas berdasarkan desain pemboran dan waktu yang diperlukan

FORMATION EVALUATION

- Menentukan kebutuhan tes evaluasi formasi
- Menentukan kontraktor yang bertanggung jawab atas tes yang dilakukan
- Menentukan waktu untuk menyelesaikan *testing*
- Menentukan waktu dimana semua peralatan dan personil berada di lokasi pemboran
- Menentukan pengaruh waktu terhadap biaya dari pertimbangan di atas


Evaluasi
Desain
Eksekusi

Drilling Functions

- Transmission of energy to the system-rock interface
- Reduction of the rock
- Removal of the rock
- Maintenance of the borehole (formation stability) while drilling
- Control of formation fluids (well control)
- Preservation of the borehole (completion)

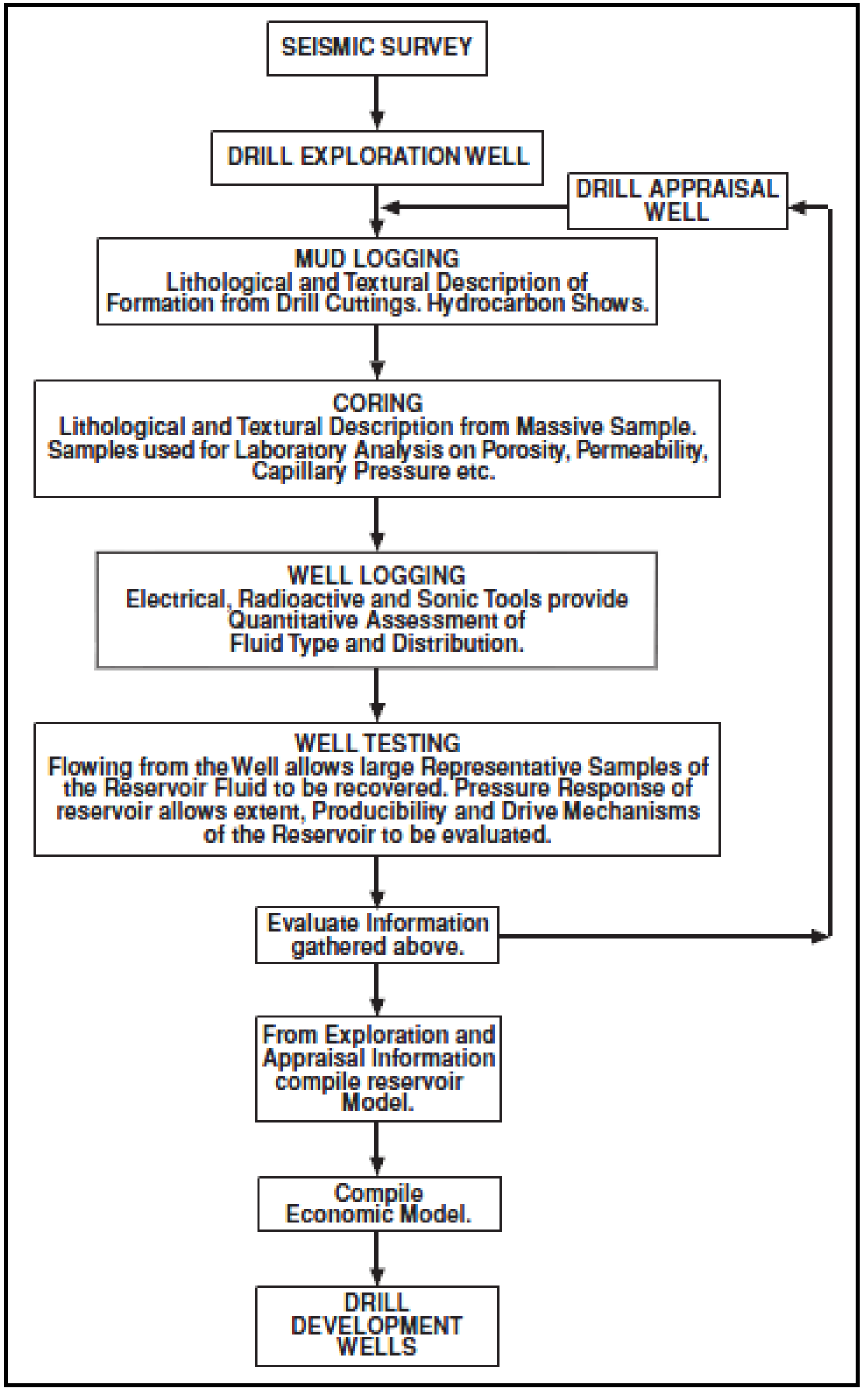
Technical & institutional constraints of drilling functions

- Environmental impact
- Operational safety
- Government regulations
- Directional drilling and control
- Sensing and communication

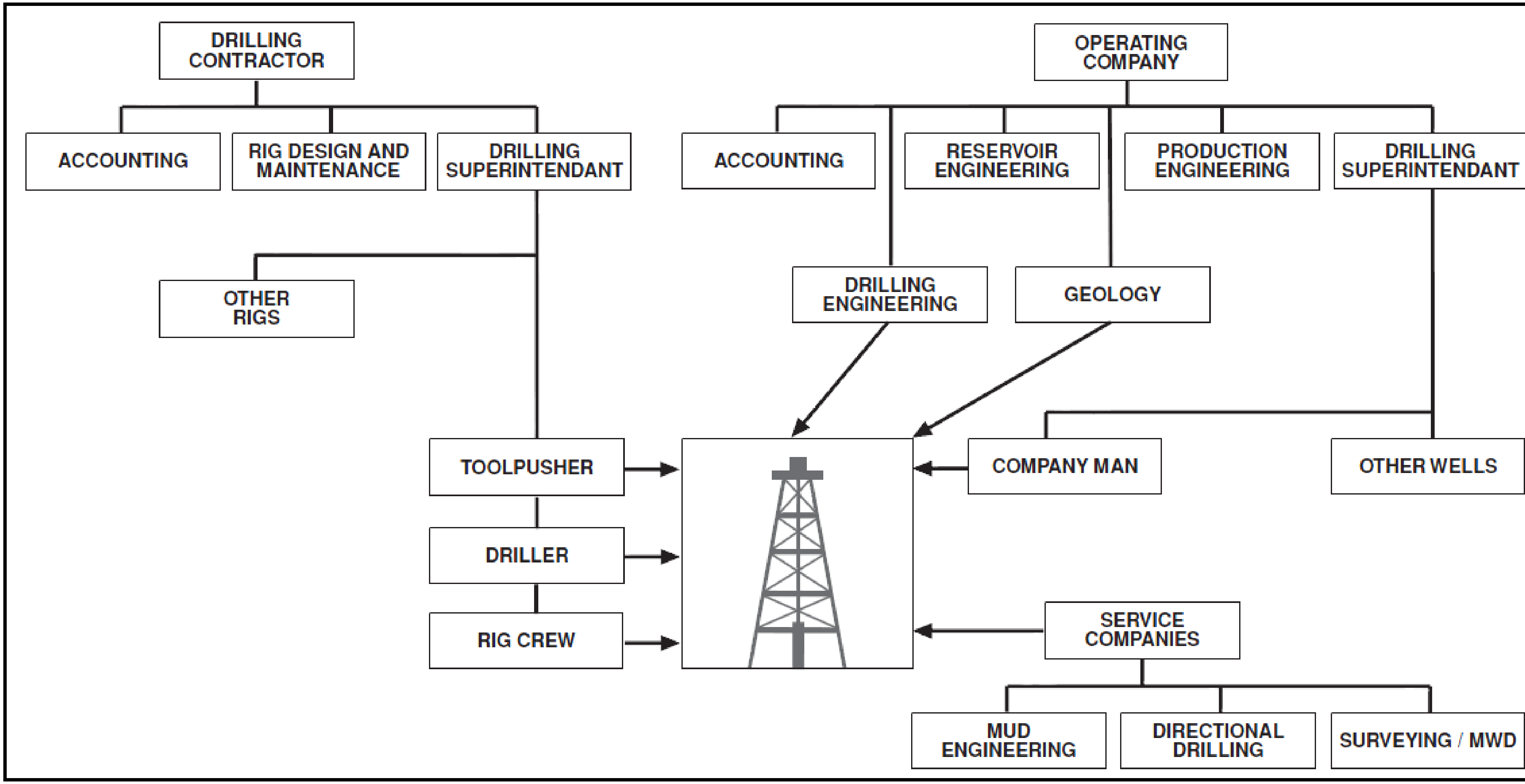
Performance Analysis

- Non-Productive Time
- Productive Time
- Quality Well Delivery Process
- Unit Development Cost
- Production Attainment

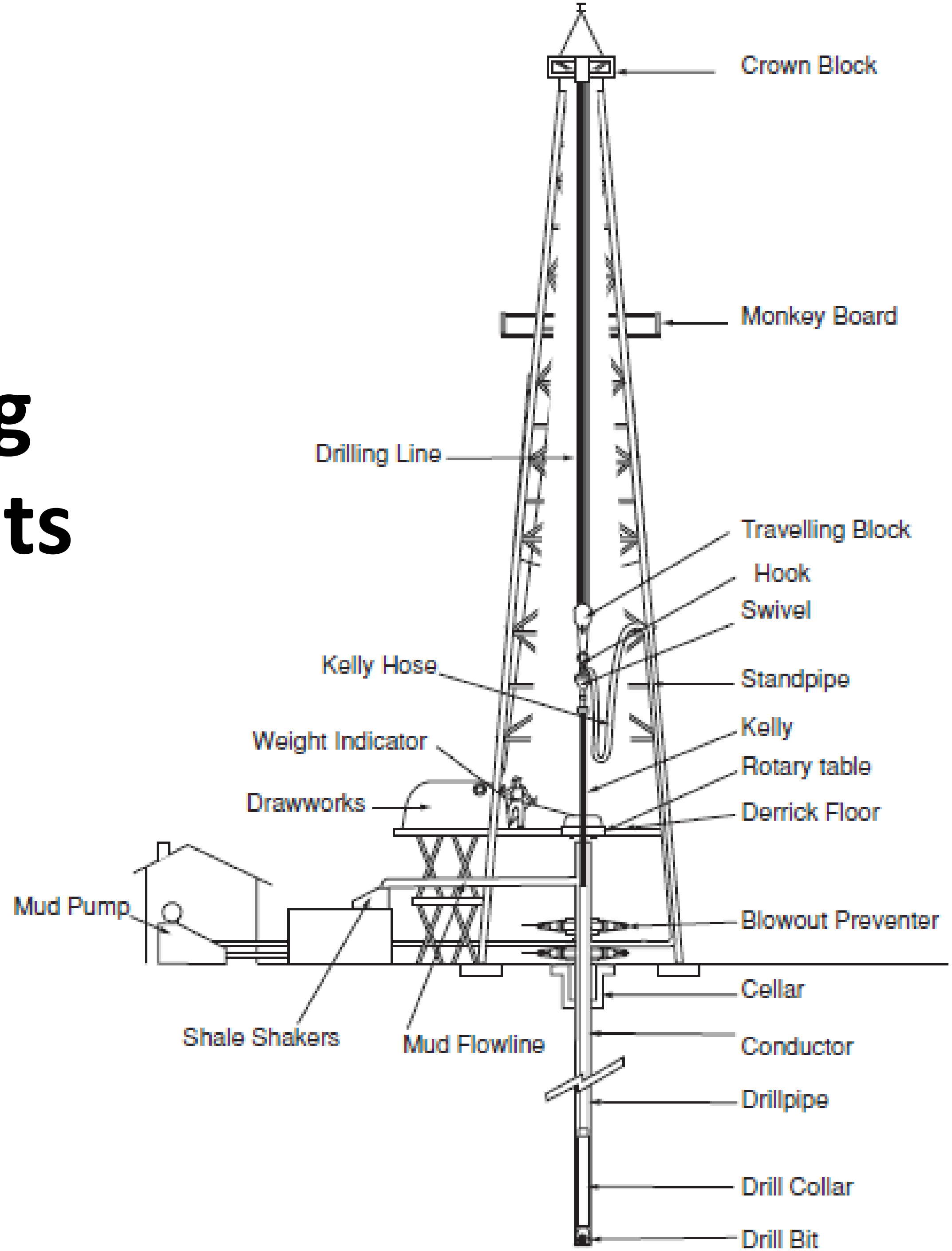
Role of drilling in field development



Personnel involved in drilling a well



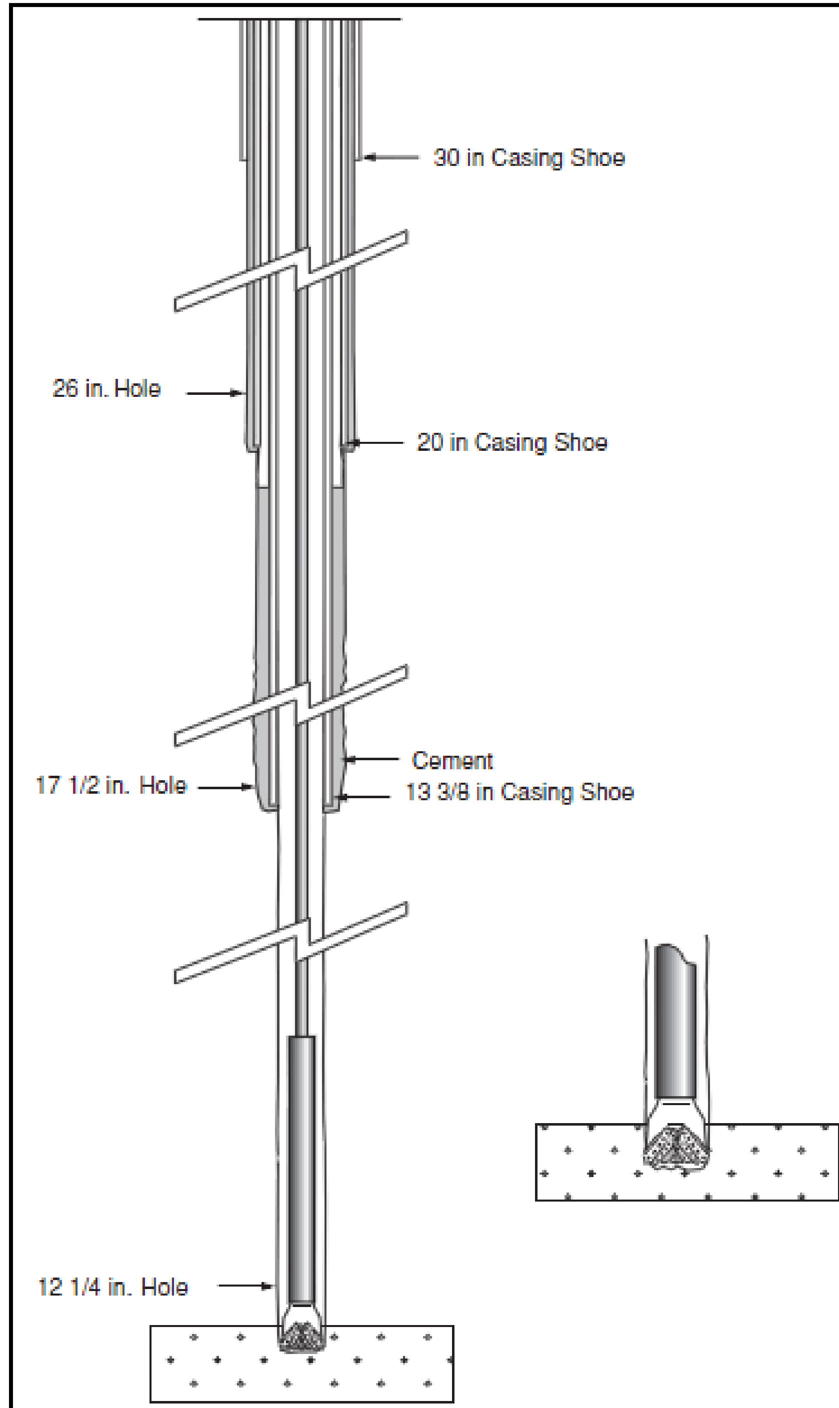
Drilling rig components



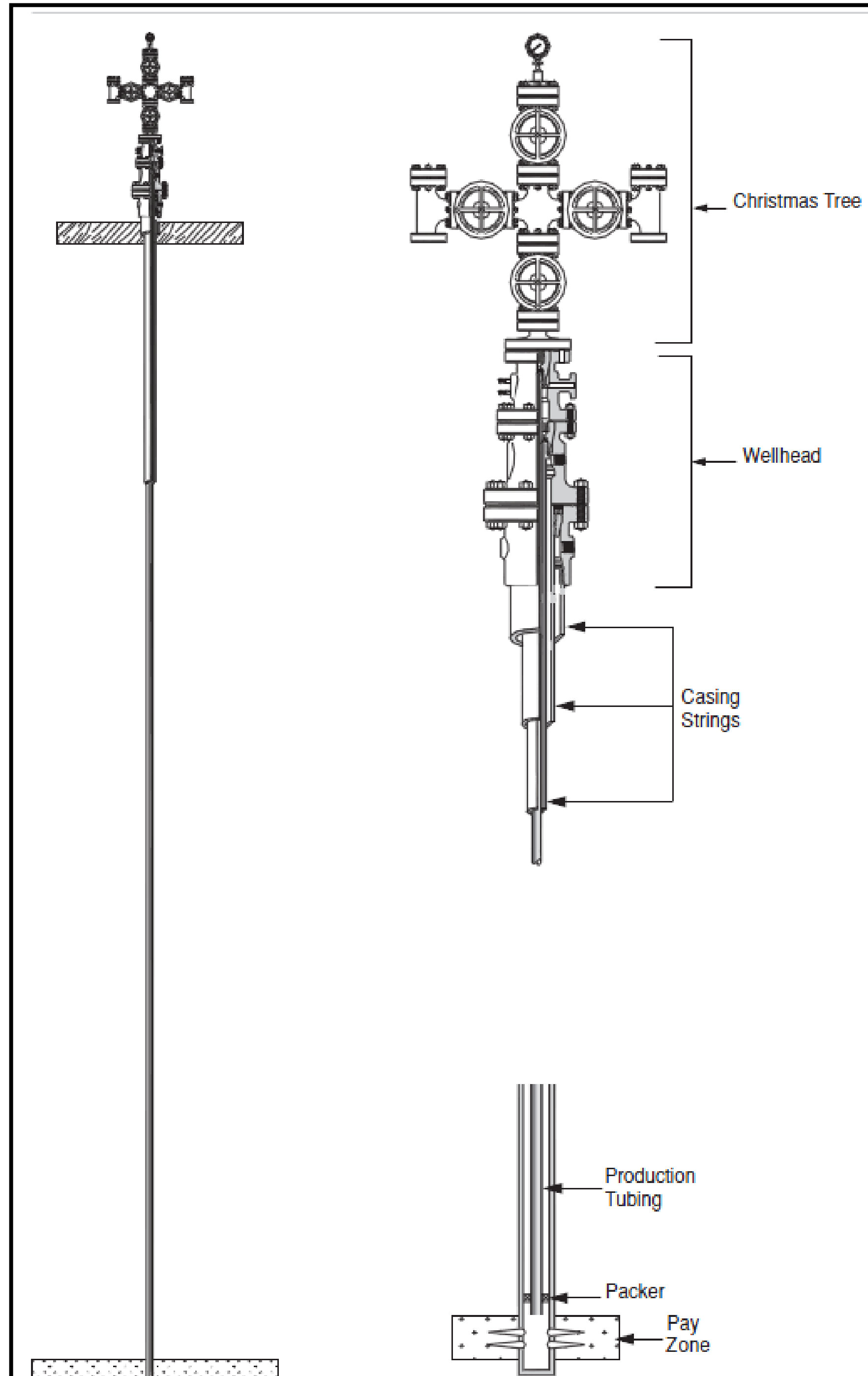
Regulation

How a well is drilled

Typical hole and casing sizes



Completion schematic



Breakdown of Well Costs

	($1000)	(%)
Wellhead	105	1.1
Flowline and surface equipment	161	1.7
Casing and downhole equipment	1465	15.5
Sub- total	1731	18.3
Drilling contractor	2061	21.8
Directional drilling/surveying	319	3.4
Logging/testing/perforating	603	6.4
Mud processing/chemicals	858	9.1
Cementing	288	3.0
Bits	282	3.0
Sub-total	4411	46.7
Transport	1581	16.7
Equipment rental	391	4.1
Communications	120	1.3
Mobilisation	686	7.3
Power and fuel	225	2.4
Supervision	300	3.2
Sub-total	3303	35.0
Total well cost	$9,445,000	

Time breakdown for a North Sea well (fixed platform)

	HOURS	%
Drill	552.0	41.9
Trips/Lay Down Drill Pipe	195.0	14.8
Directional Surveys	104.0	7.9
Core/Circ. Samples	91.5	6.9
Guide Base/Conductor	60.0	4.6
Wash/Ream/Clean Out Borehole	59.0	4.5
Lost Time	49.5	3.8
Run Casing/Tubing/Packer	37.5	2.8
Nipple down, up/Run Riser	37.0	2.8
Log/Set Packer/Perforate	26.5	2.0
Test Bops/Wellhead	25.0	1.9
Rig Maintenance	20.5	1.6
Circ. & Cond./Displace Mud	20.5	1.5
Fishing/Milling	20.0	1.5
Cement/Squeeze/WOC	18.0	1.4
Rig Down/Move/Rig Up	2.5	0.2
TOTAL	1318.5hrs (55 days)	100.0

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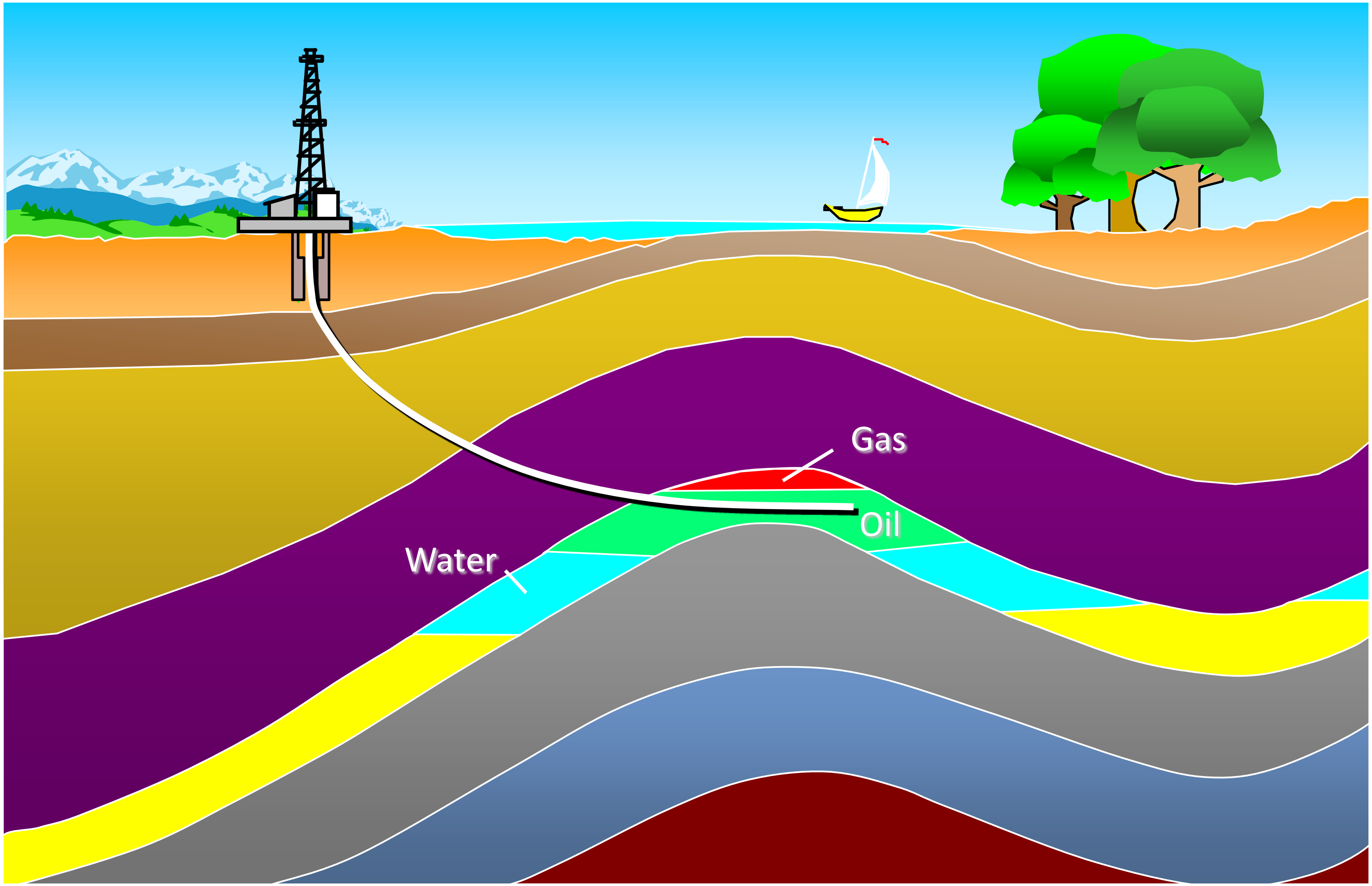
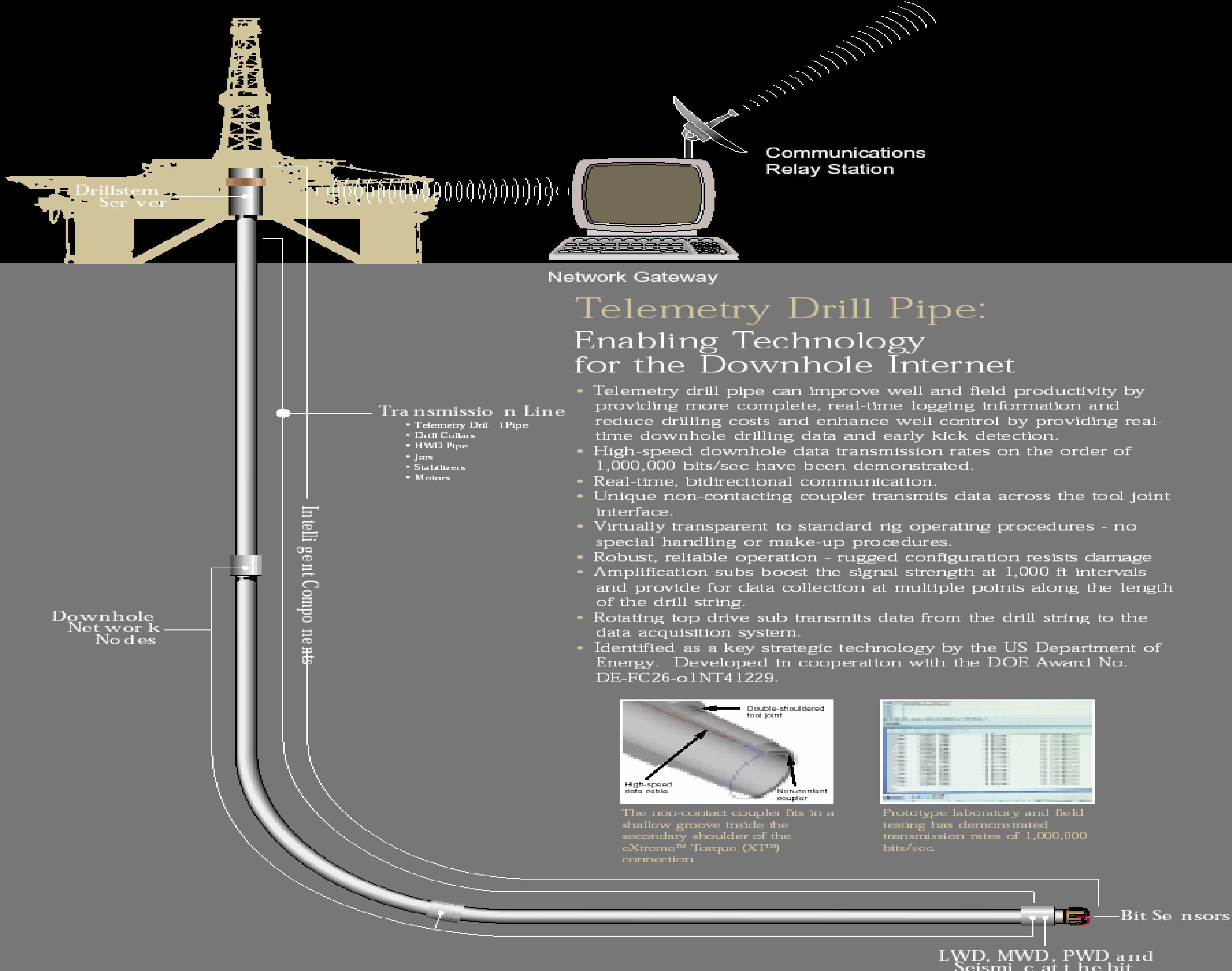
Horizontal Drilling





Telemetry Drill Pipe:

Enabling Technology for the Downhole Internet

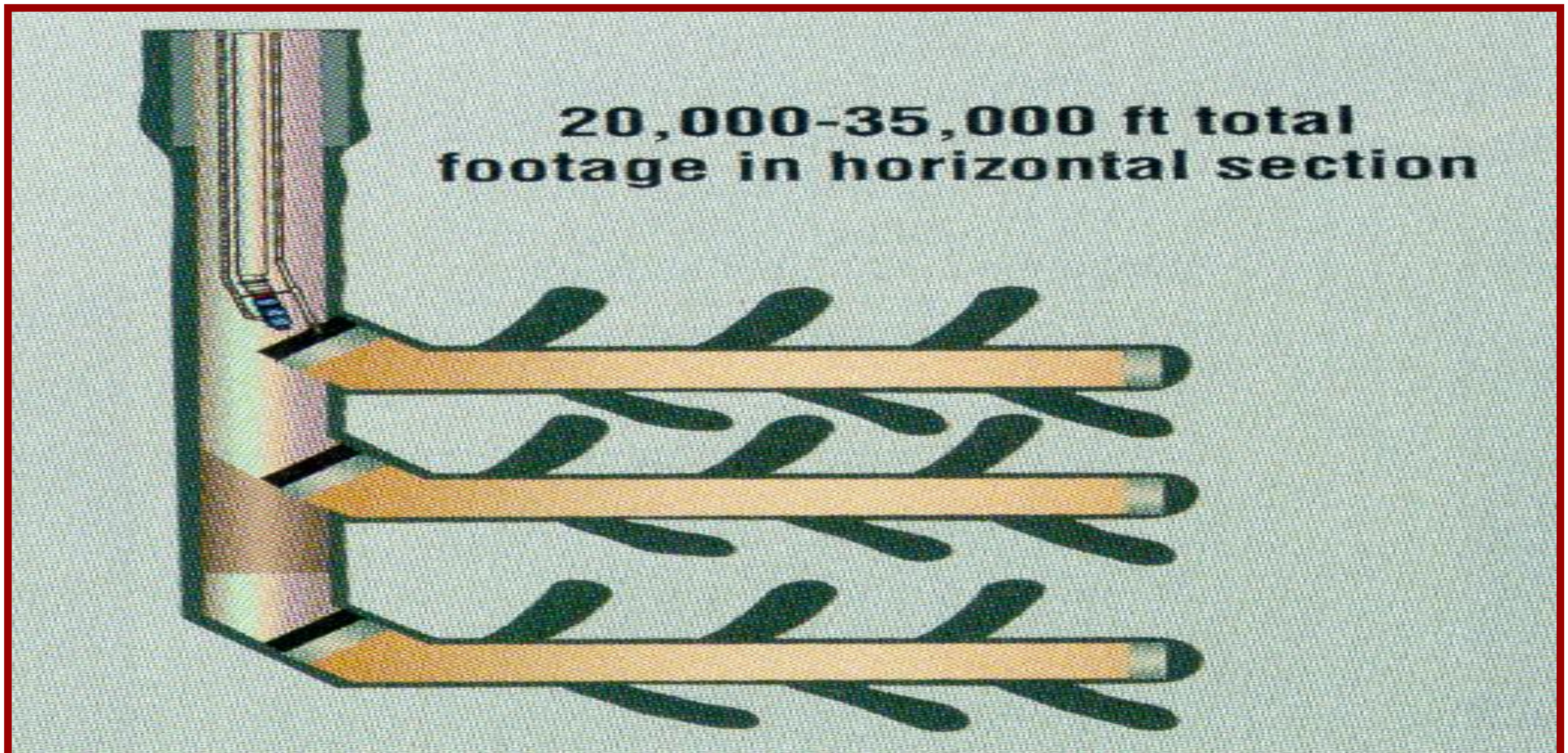
- Telemetry drill pipe can improve well and field productivity by providing more complete, real-time logging information and reduce drilling costs and enhance well control by providing real-time downhole drilling data and early kick detection.
- High-speed downhole data transmission rates on the order of 1,000,000 bits/sec have been demonstrated.
- Real-time, bidirectional communication.
- Unique non-contacting coupler transmits data across the tool joint interface.
- Virtually transparent to standard rig operating procedures - no special handling or make-up procedures.
- Robust, reliable operation - rugged configuration resists damage
- Amplification subs boost the signal strength at 1,000 ft intervals and provide for data collection at multiple points along the length of the drill string.
- Rotating top drive sub transmits data from the drill string to the data acquisition system.
- Identified as a key strategic technology by the US Department of Energy. Developed in cooperation with the DOE Award No. DE-FC26-01NT41229.

The non-contact coupler fits in a shallow groove inside the secondary shoulder of the eXtreme™ Torque (XT™) connection

Prototype laboratory and field testing has demonstrated transmission rates of 1,000,000 bits/sec

Complex Wells

Stacked Fishbone Wells



Summary of functional descriptions

SYSTEM TYPE	DRILLING FUNCTIONS					
	TRANSMIT ENERGY	REDUCE ROCK	REMOVE ROCK	CONTROL WELL	KEEP HOLE STABILITY	PRESERVE WELLBORE
BASELINE	Mechanical energy to rock through rotary table and drillstring; drill pipe moved by drawworks	Crushing or shearing by roller-cone or drag bits	Drilling mud, circulated by pumps, and/or gas, driven by compressors	Mechanical closure by blow-out preventers; pressure control by mud column	Hydrostatic pressure of mud; chemical treatment by mud additives	Steel casing cemented in place; handled by mast and drawworks
COILED TUBING	Hydraulic power through tubing and downhole motor; continuous drillpipe on reel	Baseline	Baseline	Baseline	Baseline	Baseline; casing handled by jacks
JET ASSISTED	Baseline, plus high pressure supplied to the bit	Baseline, augmented by high-pressure jets	Baseline	Baseline	Baseline	Baseline
PROJECTILE ASSISTED	Baseline, plus chemical explosive	Baseline, augmented by projectile impact	Pneumatic; air compressor	Blowout preventer	None	Baseline
MICROWAVE	Baseline, plus electric/thermal (microwave)	Baseline, enhanced by heating rock	Pneumatic, air compressor	Blowout preventer	None	Baseline
MUD HAMMER	Baseline, plus hydraulic power to hammer	Roller or flathead bits crushing rock by impact	Baseline	Baseline	Baseline	Baseline
THERMAL SPALLATION	Primarily chemical (fuel and oxidizer)	Spallation due to high thermal gradients or differential expansion	Gas; air compressor plus products of combustion	Blowout preventer	None	Baseline
SPARK DRILL	Electrical energy delivered to the drill head	Spark-driven shock wave	Baseline	Baseline	Baseline	Baseline
EXPLOSIVE DRILL	Chemical explosive delivered to rock face	Explosively-driven shock wave, or explosive-enhanced conventional	Baseline	Baseline	Baseline	Baseline
ROCK MELTERS	Electrical or optical	Thermal - rock melting	Pneumatic	Blowout preventer	Glass-lined wellbore (?)	Baseline; plus glass lining (?)
PULSED-LASER WATER JET	Optical (fiber optic)	Mechanical resonance	Undetermined	Undetermined	Undetermined	Baseline

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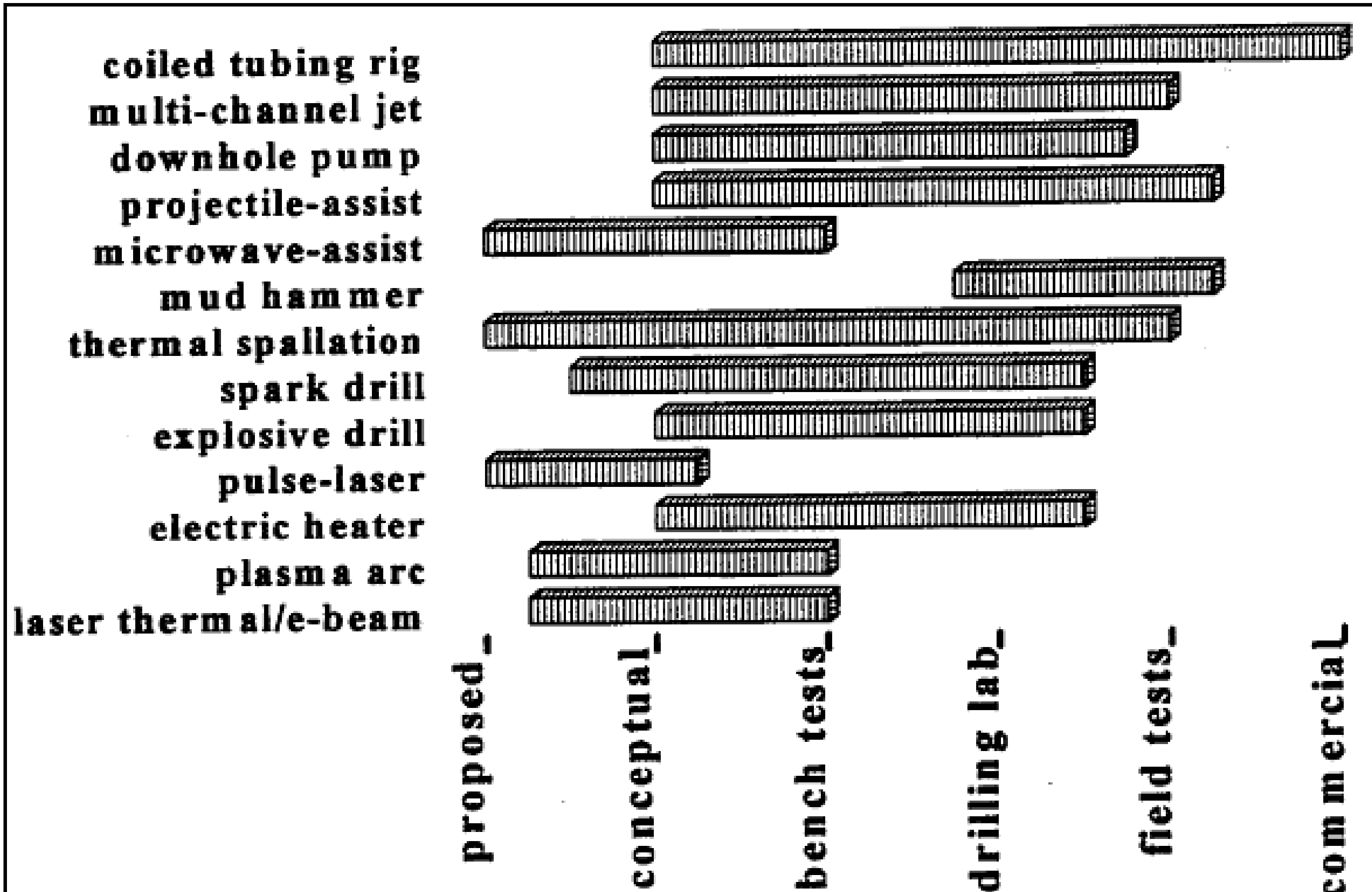
Technical maturity of advanced systems



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SYSTEM LIMITATIONS, NEEDS, AND COMMON PROBLEMS

SYSTEM	LIMITATIONS	TECHNOLOGY NEEDS
COILED TUBING	• CT units are expensive • Increased differential sticking • Hole size, hydraulics limited by tubing size • Weight-on-bit and torque limited • Tubing fatigue	• Less expensive downhole motors • Undefined • Larger tubing and reels • Downhole thruster-retractor • Improved materials; larger reels
JET ASSISTED (full surface press.)	• Requires the full fluid-supply system to withstand high pressure • Difficult to seal drill-pipe connections • Working fluid pH is critical to pipe life • High operating cost • Pressure-safety concerns	• High-pressure pumps, hoses, swivel, drill-pipe • Improved joint-seal design • Drilling fluid development, pipe materials • Undefined • Undefined
JET ASSISTED (multiple conduit)	• High pressure losses • Time-consuming joint makeup • Dual pumps and flow channels required • Pressure-safety concerns	• Larger conduit • Improved joint design • Multi-conduit swivel, drill-pipe, and bit • Undefined
JET ASSISTED (downhole intensifier)	• Not developed to the point of field service • Limited high-pressure flow rate • Dual channels from intensifier to bit	• Complete and test intensifier design • Re-design intensifier for higher flow rate (?) • Multi-conduit drill-pipe and bit
PROJECTILE ASSISTED	• Complex firing mechanism and magazine may limit life • System does not function in liquid	• Field-test prototype for extended time; refine design • Develop proposed valve system
MUD HAMMER	• Designs with total-mud-flow valving hinder well control • Interferes with acoustic or mud-pulse MWD • Damage at hammer-anvil interface • Valve erosion from mud abrasives • Fatigue failure of valve and/or spring	• Use partial flow to drive reciprocating mechanism • Develop non-acoustic MWD • Re-design hammer/anvil interface • Re-design valve (or materials development) • Re-design valve system
THERMAL SPALLATION	• Difficult to maintain hole gauge • Must (probably) operate in air • Needs umbilical for fuel, air, cooling water • Performance varies with rock type • Safety concerns	• Downhole thruster/control head • Pursue development of underwater system • Multi-channel pipe or downhole separator • Spallation augments mechanical drilling • Undefined
SPARK DRILL	• Not demonstrated as a drilling system • Requires electrical conduit downhole • Insulation breakdown from high currents • Gas generation downhole	• Build and demonstrate prototype • Electrical conduit in drill-pipe • Undefined • Undefined
EXPLOSIVE DRILL	• Efficiency at depth is not known • Mud flow for cleaning disperses explosive • Explosive must be reliably initiated • Explosive must be counted and tracked • Safety concerns with mis-fire	• Test prototype or build test facility • Undefined • Develop initiation system • Develop counting and tracking system • Re-configure explosive delivery system
MICROWAVE	• Not known if system will operate in liquid • Must transmit microwave energy downhole	• Analysis and testing to resolve this issue • Coaxial cable, wave guide, or downhole magnetron
ROCK MELTERS (general)	• Only operate in air • Need electrical conduit downhole • Difficult to lift melted rock from hole • Variation in rock behavior when melted	• Undefined • Electrical conduit in drill-pipe • Undefined • Undefined
ROCK MELTERS (laser, e-beam, plasma torch)	• Require stand-off control • Plasma torch requires separate gas for plasma • E-beam produces X-rays • Laser has low power and efficiency	• Thruster-retractor control head • Multi-conduit drill-pipe • Undefined • Use to kerf and augment mechanical
PULSED-LASER WATER JET	• Only limited laboratory data on concept • Requires laminar-flow clear water downhole • Requires additional fluid for hole cleaning • Requires stand-off control	• Develop into prototype drilling system • Undefined • Multi-conduit drill-pipe • Thruster-retractor control head

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