Fundamentals of Onshore Drilling

Basics of Rotary Drilling

Rotary Operations / Coring

presentation No. 2

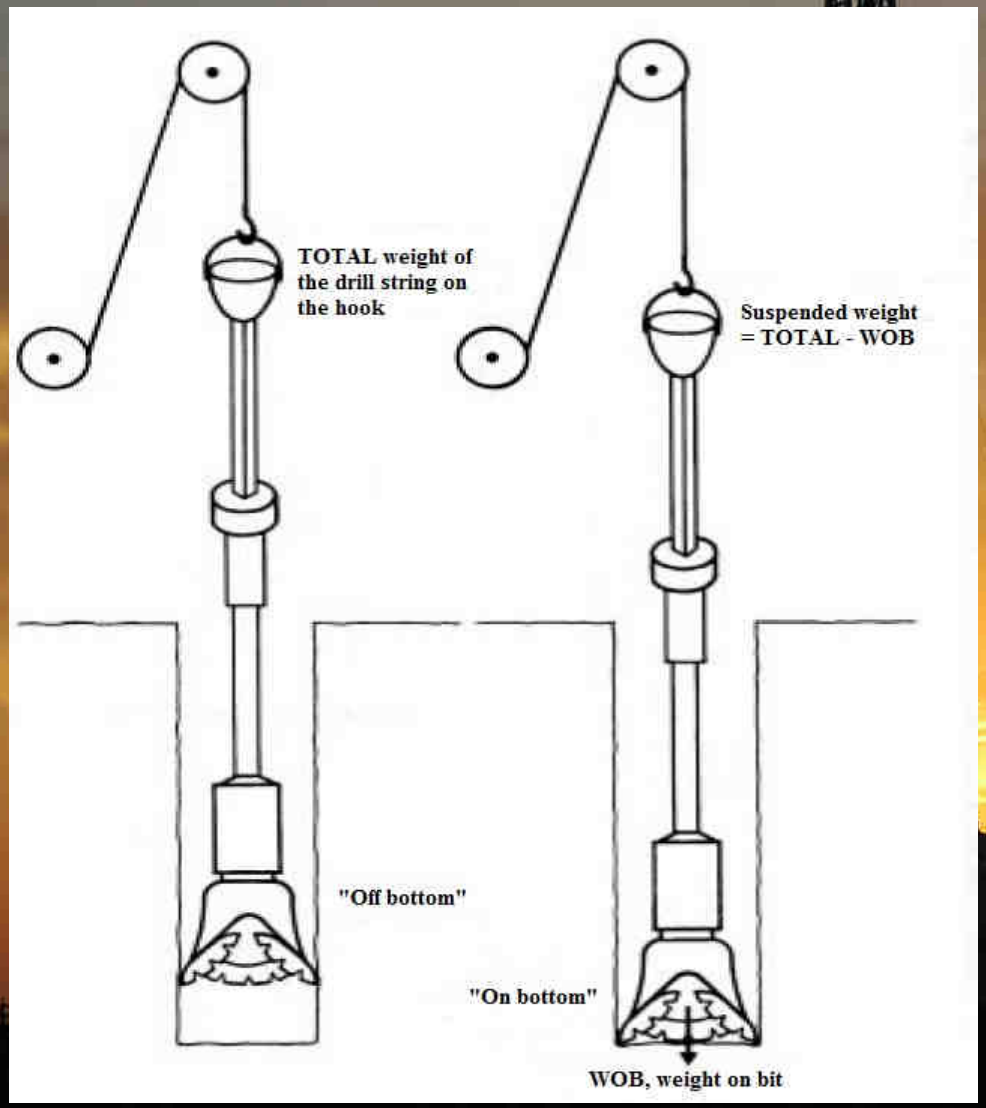
references:

- Bernt S. Aadnoy, Iain Cooper, Stefan Z. Miska, Robert F. Mitchell, Michael L. Payne: ***Advanced Drilling and Well Technology***. SPE 2009, ISBN: 978-1-55563-145-1.
- Robello G. Samuel, Xiushan Liu: ***Advanced Drilling Engineering – Principles and Design***. Gulf Publishing Company, Houston Texas, 2009, ISBN: 978-1-933762-34-0.
- ***World Oil´s Handbook of Horizontal Drilling and Completion Technology***. Gulf Publishing Company, Houston, Texas 1991, ISBN: 0-87201-361-8
- ***A Primer of Oilwell Drilling***. Petroleum Extension Service, Houston, Texas 2001, ISBN: 0-88698-194-8.
- Robello, R. G.: ***Downhole Drilling Tools***. Gulf Publishing Company, Houston, Texas 2007, ISBN: 978-1933762135.
- ***2010 Drill Bit Classifier.*** World Oil September 2010.
- ***Casing References Tables 2012.*** World Oil January 2012.

Major Rotary Operations

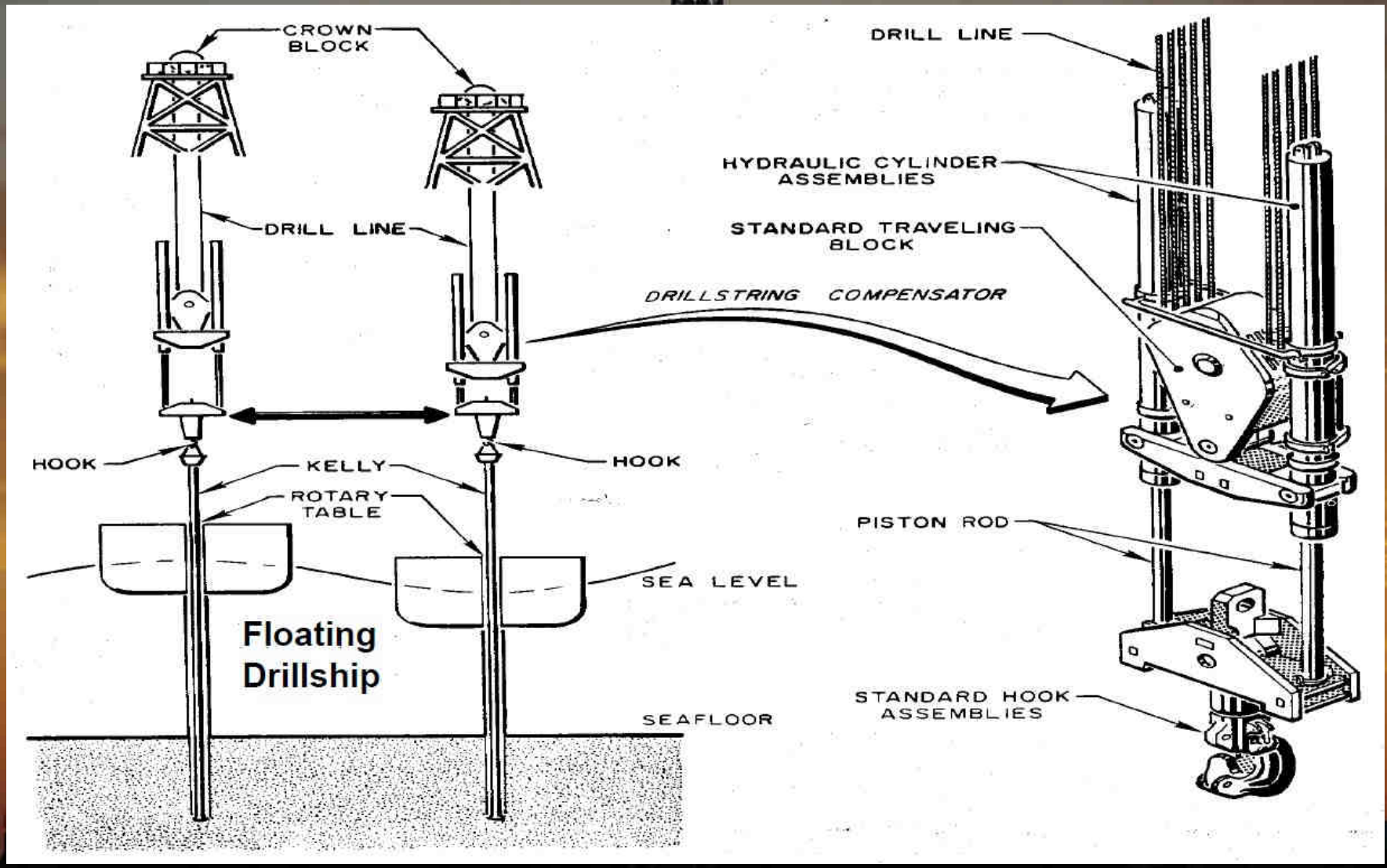
Operation	Result	Operational Steps
Drilling/Coring	Making Hole/ Cutting Core	•Applying Weight on Bit (WOB) •Rotating the Bit •Circulating Fluid
Adding Drillpipe	Lengthening the Drillstring	Screwing a new joint of drillpipe to the drillstring Circulation stopped
Roundtrip	Changing the Bit	Pulling-Out/Running-In the complete Drillstring Circulation stopped
Casing	Borehole protected by casing	Running in Casing-Pipe Joint by Joint
Cementing	Sheath of Cement in Annulus	Pumping cement slurry in annulus

Major Rotary Operations - Drilling

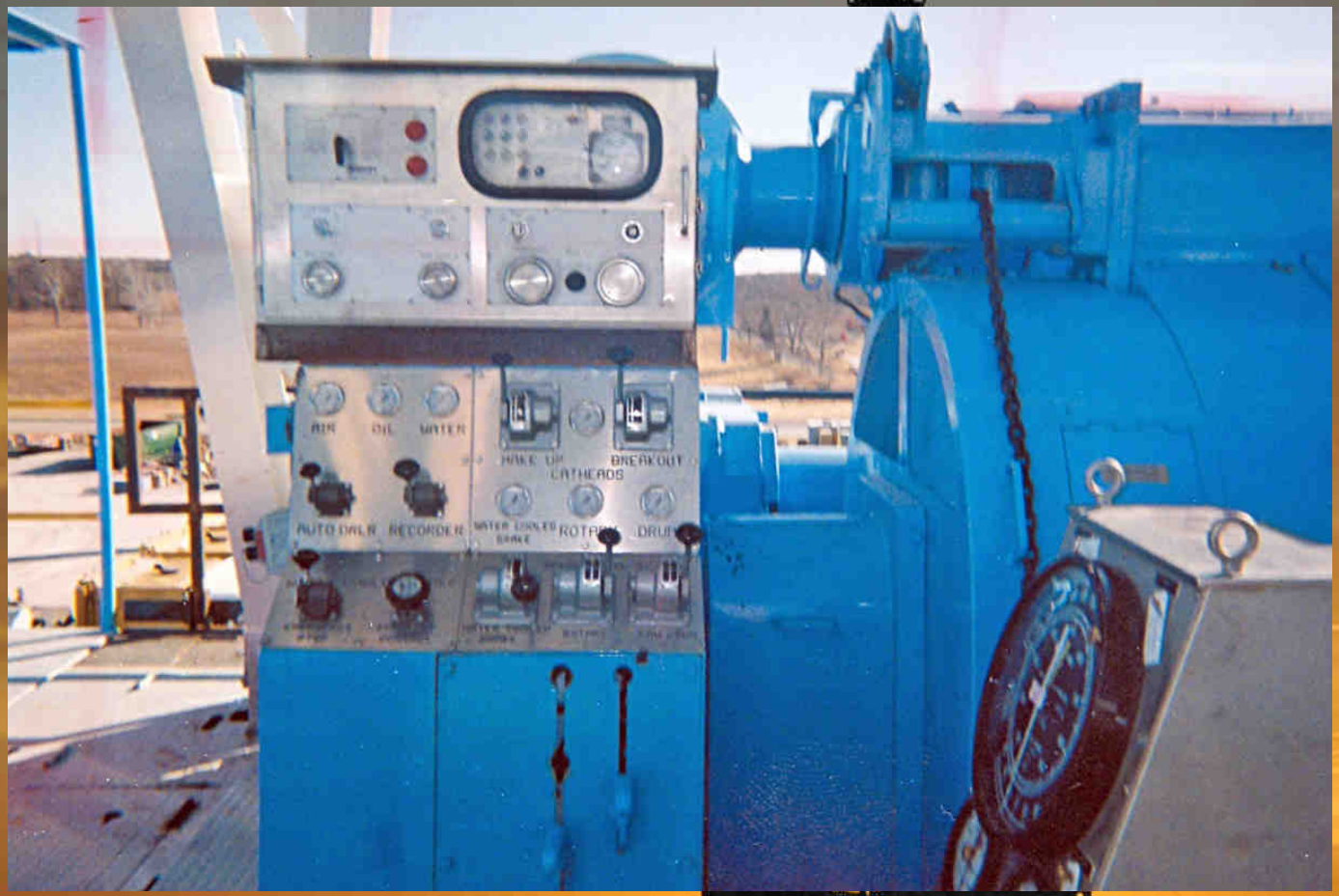


Major Rotary Operations - Drilling

Controlling WOB with a Heave Compensation System



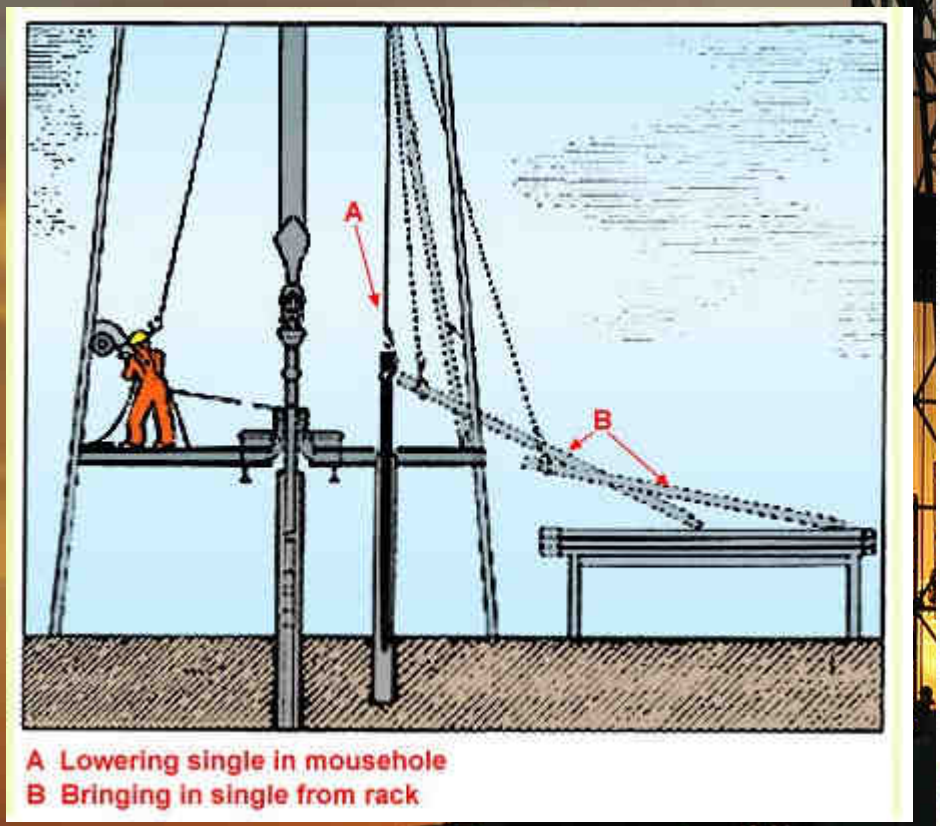
Drillers Console



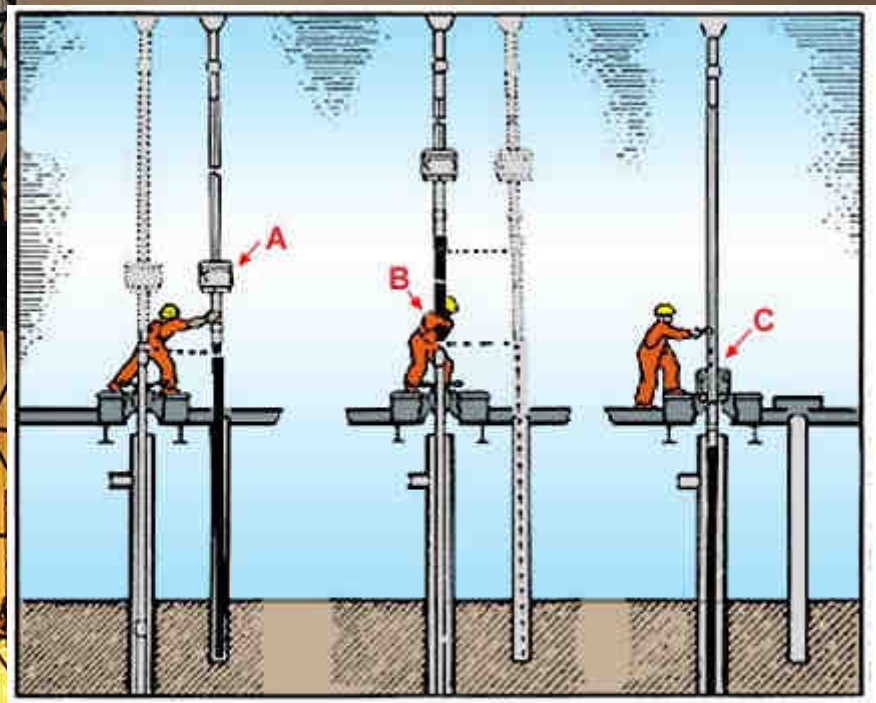
Drillers Console

Drillers Console

Major Rotary Operations – Adding Drillpipe

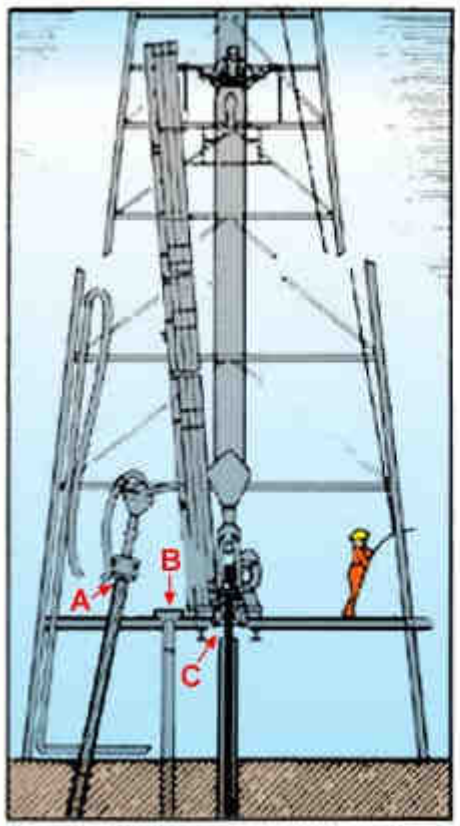


A Lowering single in mousehole
B Bringing in single from rack

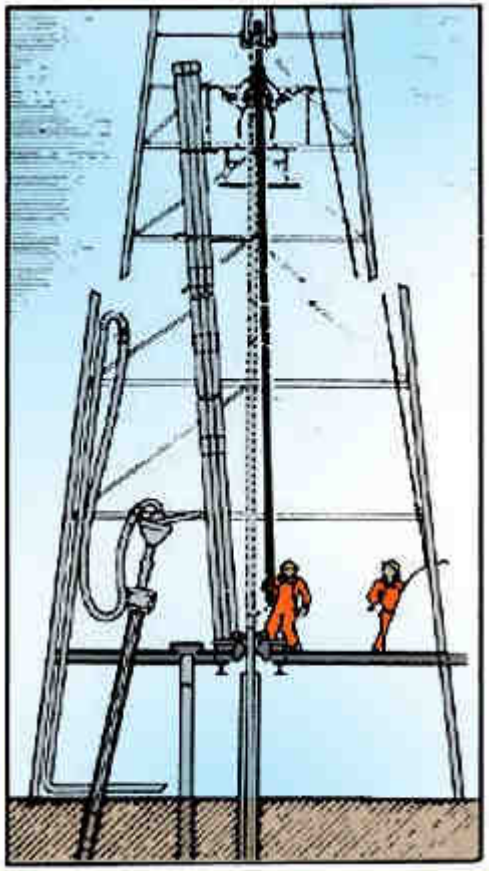


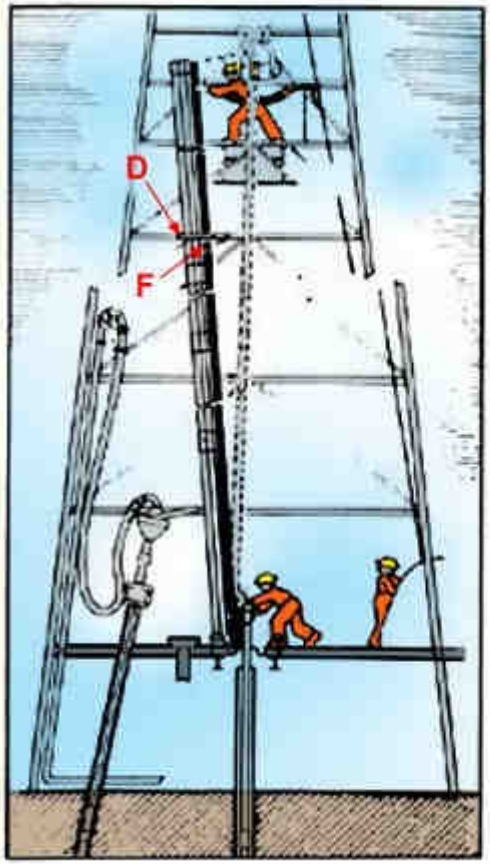
A Swinging the swivel and kelly over single for mousehole connection
B Stabbing the added single into top joint of drillpipe
C Single added and ready to make new hole

Major Rotary Operations – Adding Drillpipe



A Rat Hole
B Mousehole
C Pipe Wiper

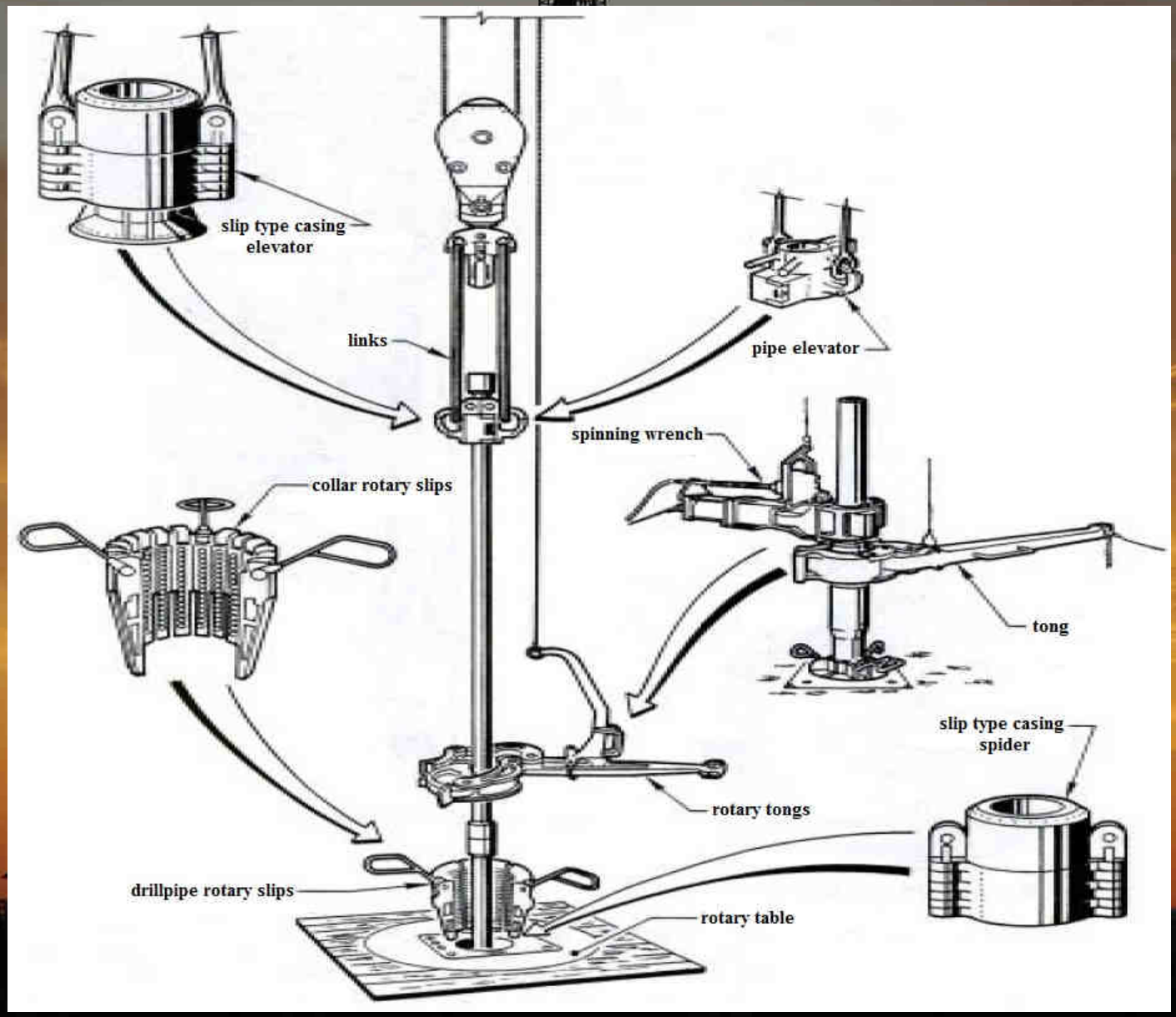




D Steel Beam
F Finger

Suspending the Drill String in the Rotary Table by Slip

Rig Components used for Manual Pipe Handling

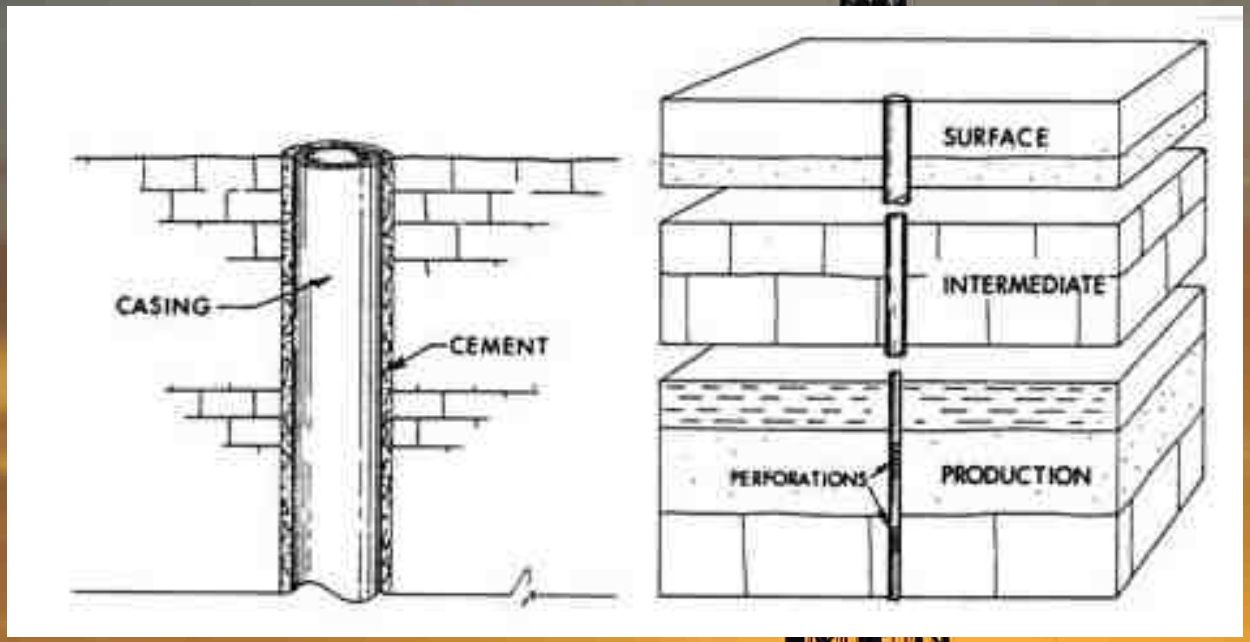


Roundtrip Operating

manually

with pipe handling system

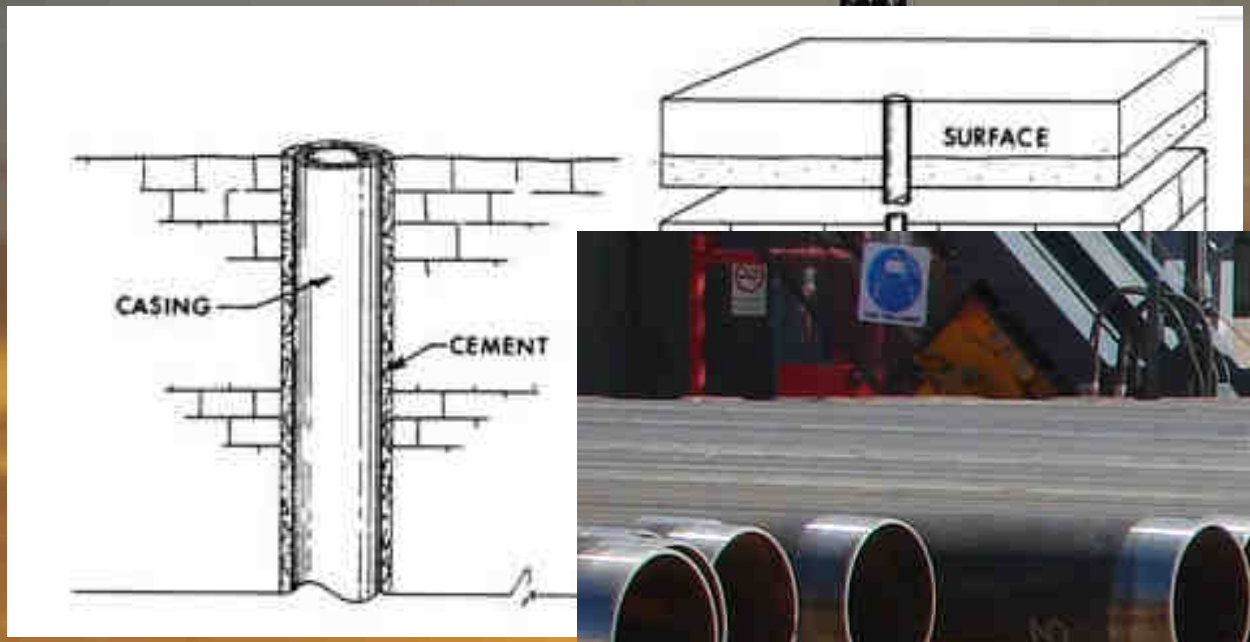
Reasons for Casing the Hole



Casing is a string of single steel pipes with lenght of 8 – 16 m connected by threaded couplings

Casing is specified by
- **outer diameter of casing pipe**
- **weight per foot (wall thickness)**
- **grade of steel**
- **type of coupling**

Reasons for Casing the Hole



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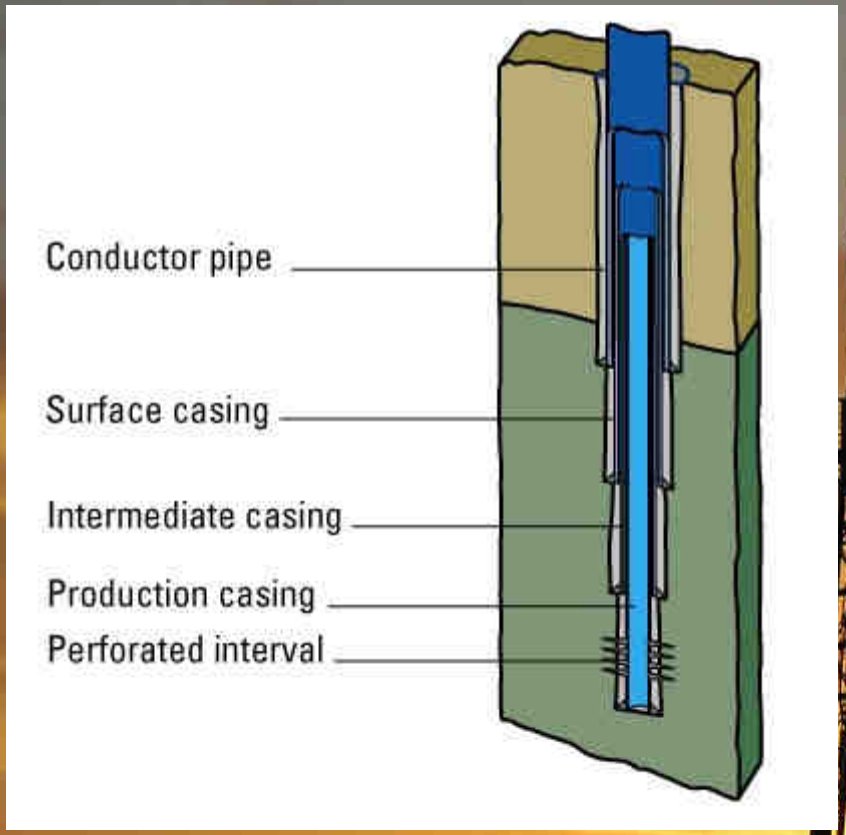
Planning Rules for Drilling and Casing Program



A good drilling and casing program is a **decisive factor** for technical and economical success of a drilling project.

Planning starts with the **minimum borehole or casing diameter** required at **target depth**.

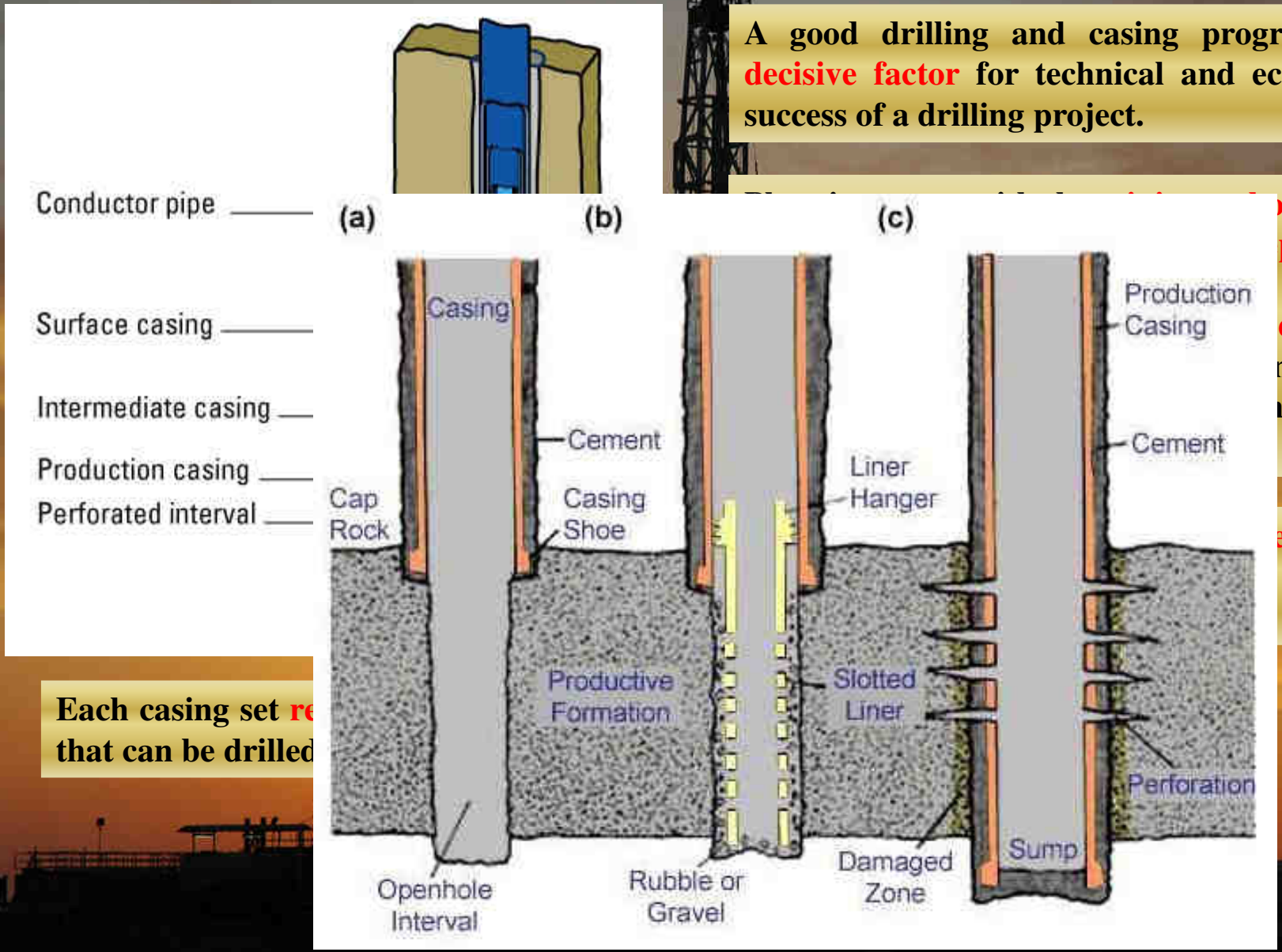
Number of **intermediate casing** and **depths of casing shoes** are determined in dependency of the **preliminary geological profile** moving up progressively to surface.

Bit Diameters and **Casing Diameters** are standartized. They have to be selected according to given sizes.

Each casing set **reduces the diameter** that can be drilled through later on.

Planning Rules for Drilling and Casing Program

A good drilling and casing program is a **decisive factor** for technical and economical success of a drilling project.



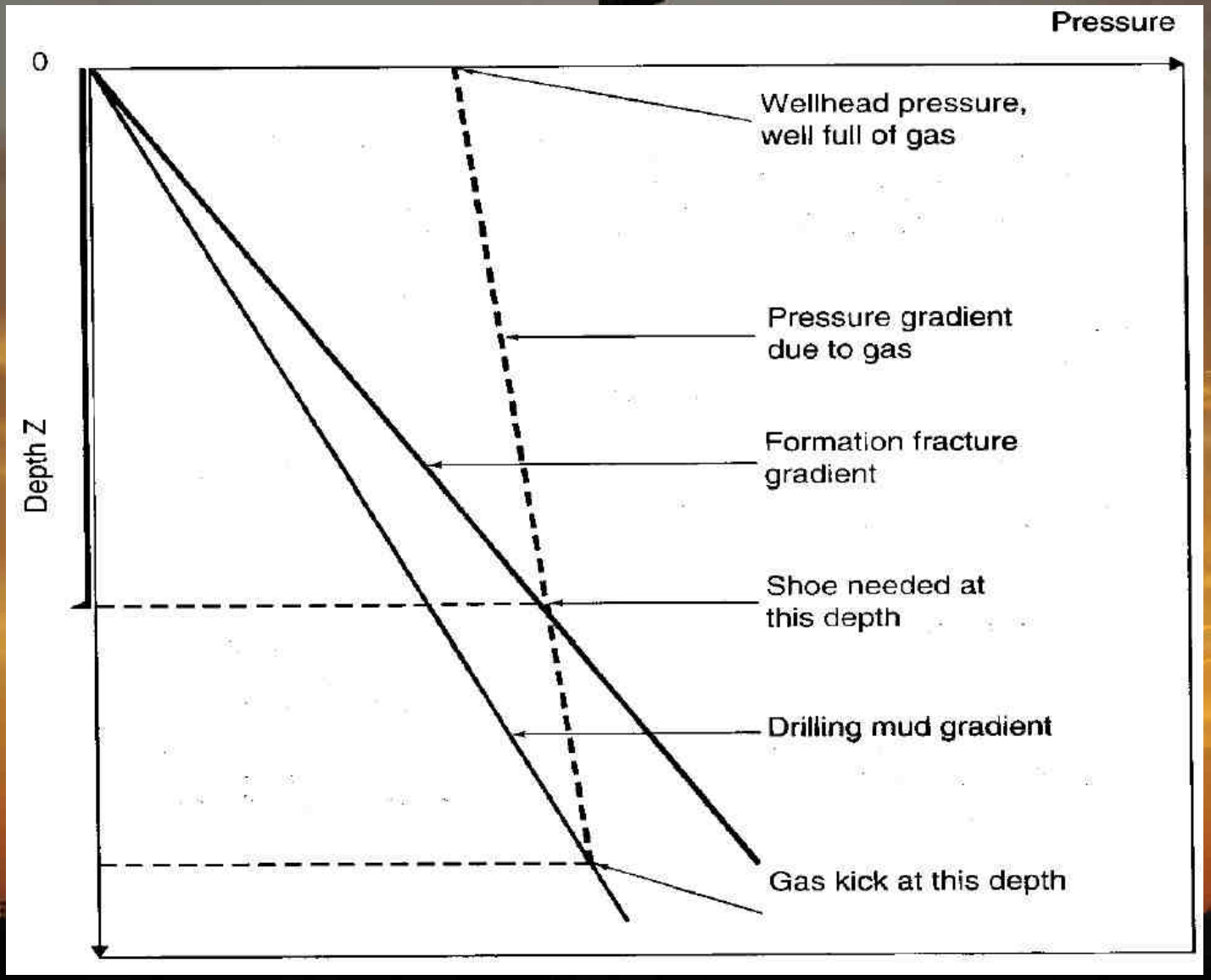
rehole or pth.

depths of ndency of oving up

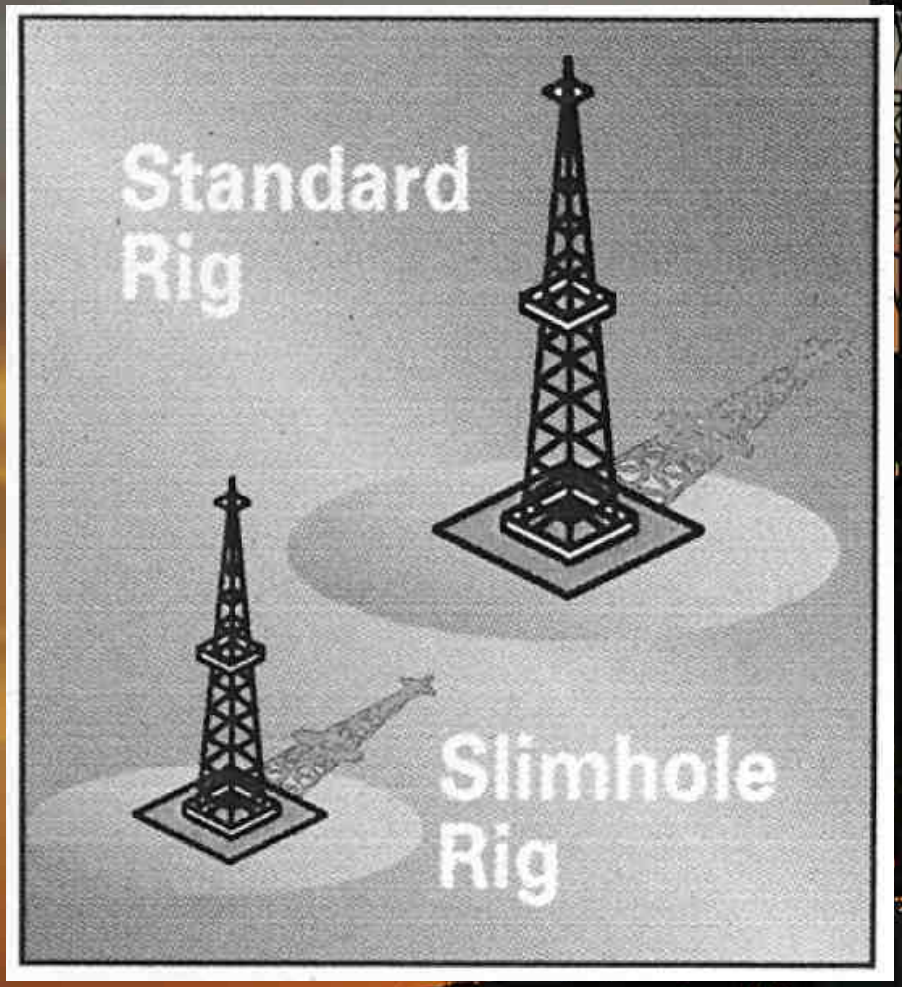
eters are selected

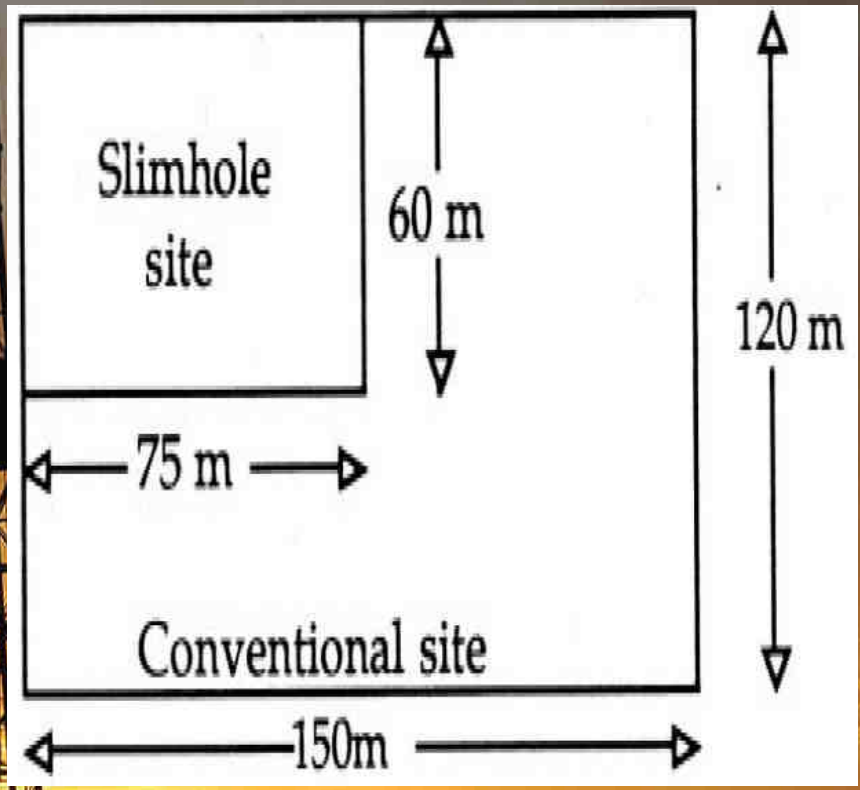
Each casing set re that can be drilled

Pressure-Depth Diagram for Determination of Casing Shoe Depth



Benefits of Slim Hole Drilling

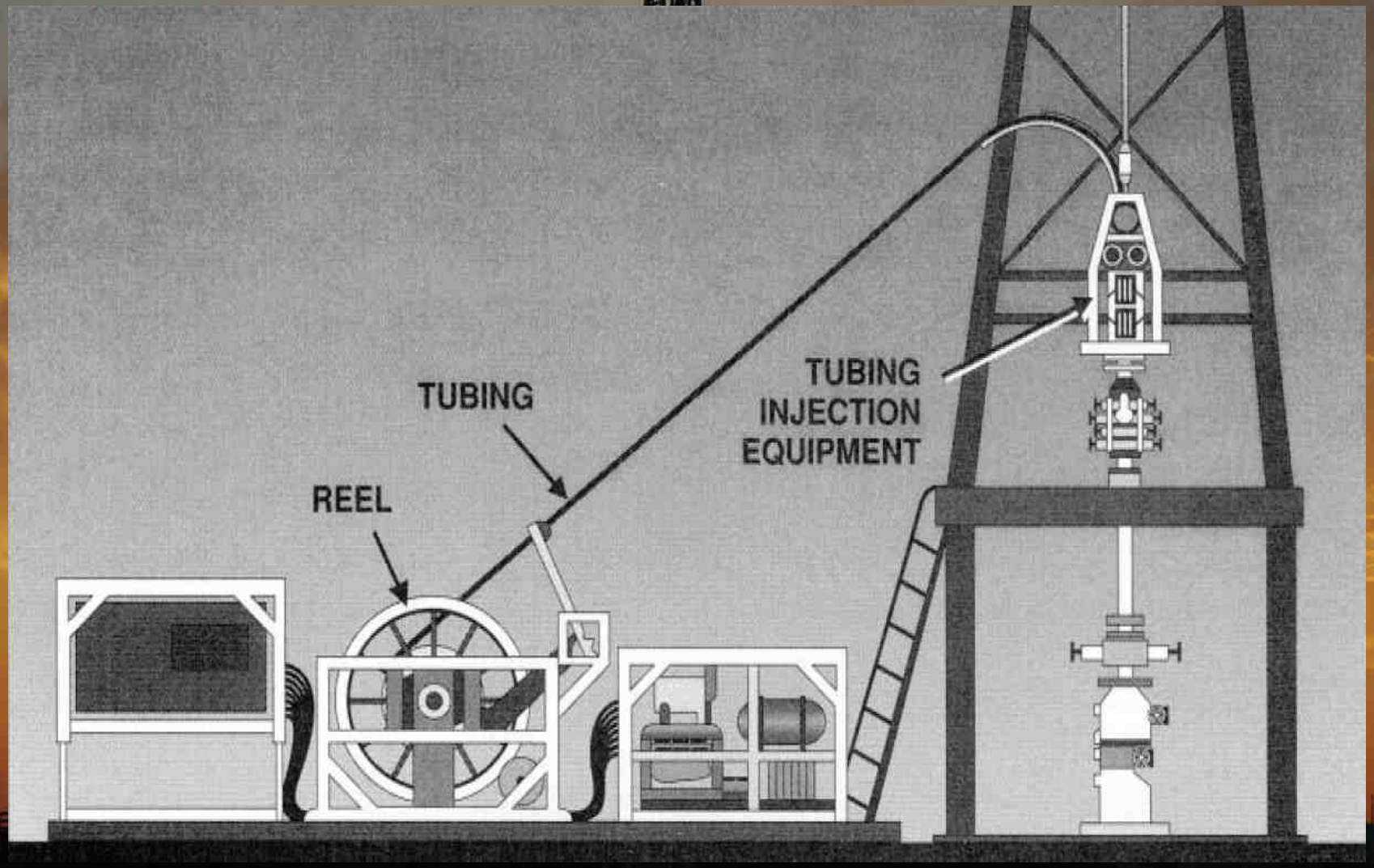




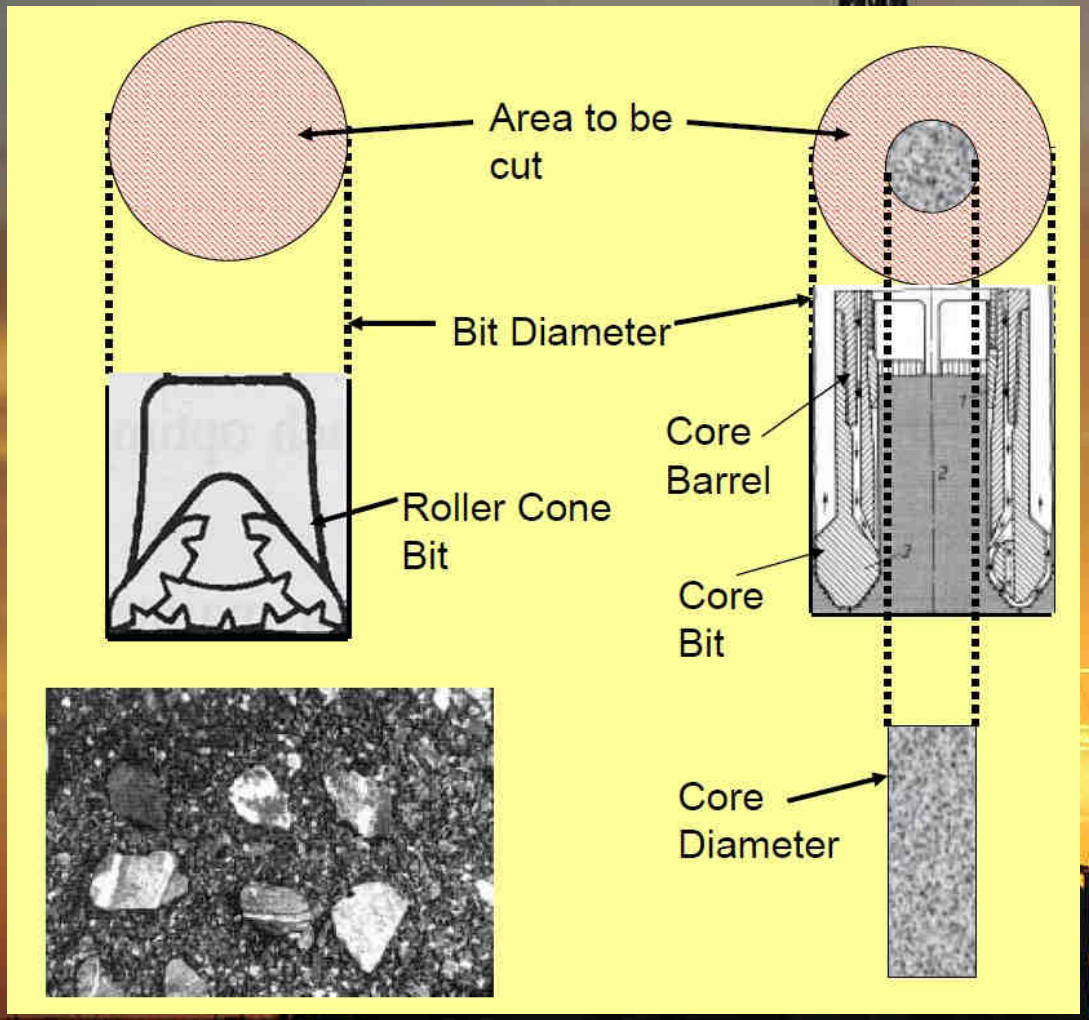
Benefits of Slim Hole Drilling:

- **hole diameters reduced by 50%**
- **requires smaller rigs**
- **site reduced by 75%**
- **overall costs reduced by 40 – 50%**

Slim Hole Drilling with Coiled Tubing Technology



Principles of Core Drilling



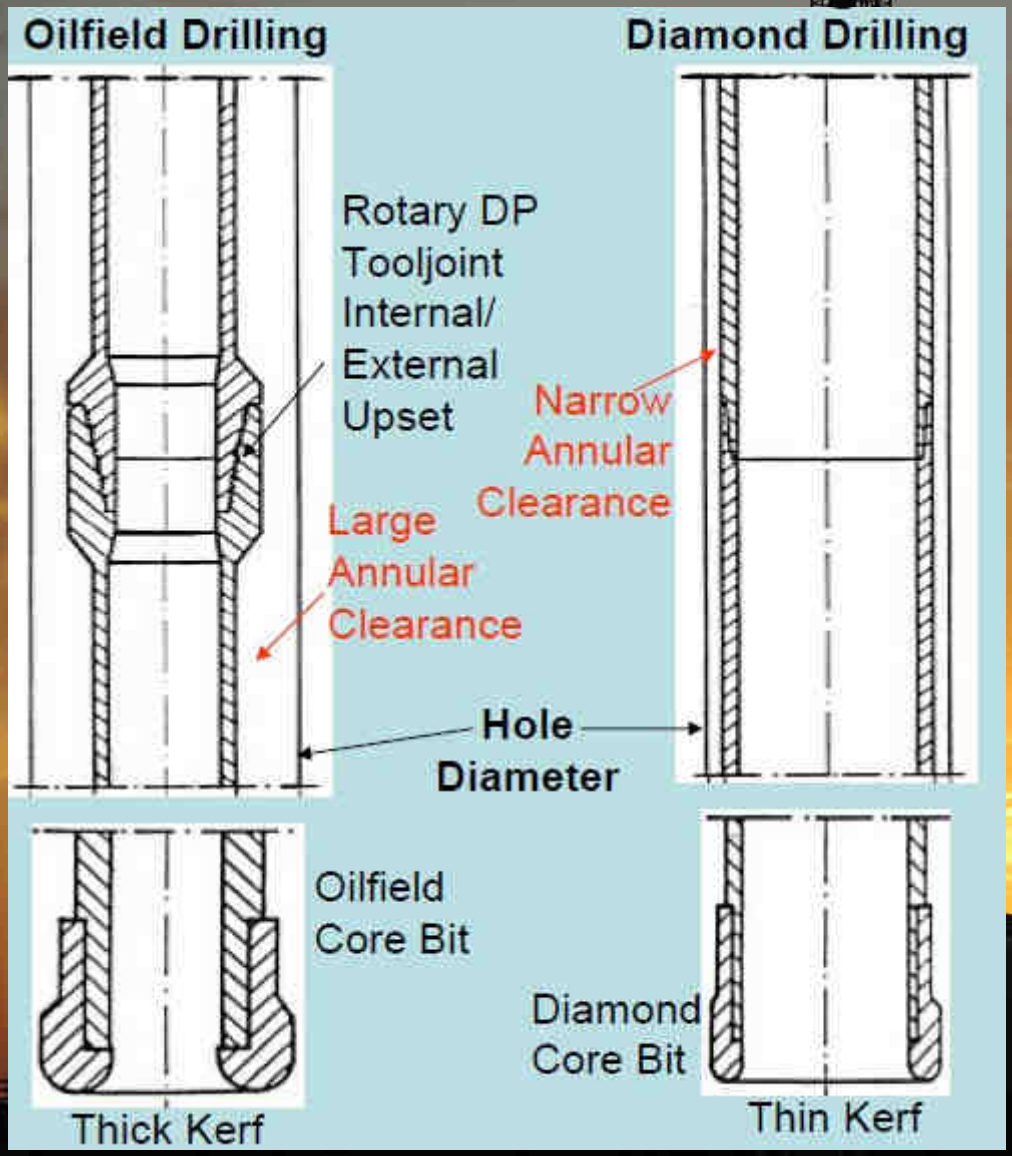
Instead of cutting the total cross – sectional area only an annular ring or kerf of rock is cut leaving a solid cylinder of uncut formation passing into the core barrel above the bit.

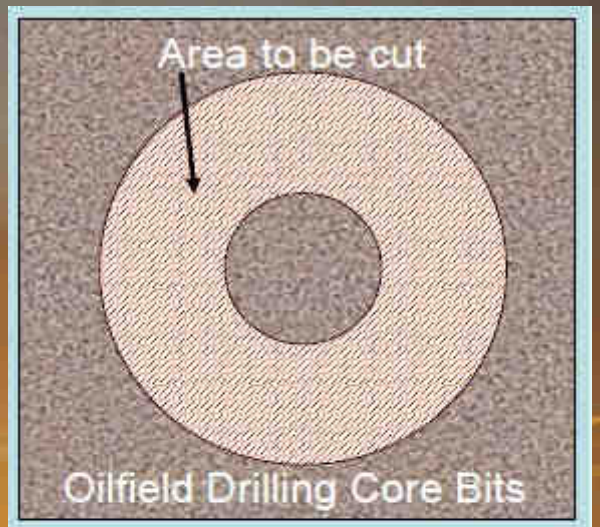
Key Components:

- **Core Bit**
- **Core Barrel**
- **Retrieving Equipment**

Reasons for Core Drilling

Core Drilling Techniques





Types of Thick Kerfed Rotary Core Bits

Surface Set Diamond Bit

PDC-Diamond Bit

Used in KTB-VB

4- and 6-Roller Cone Bit

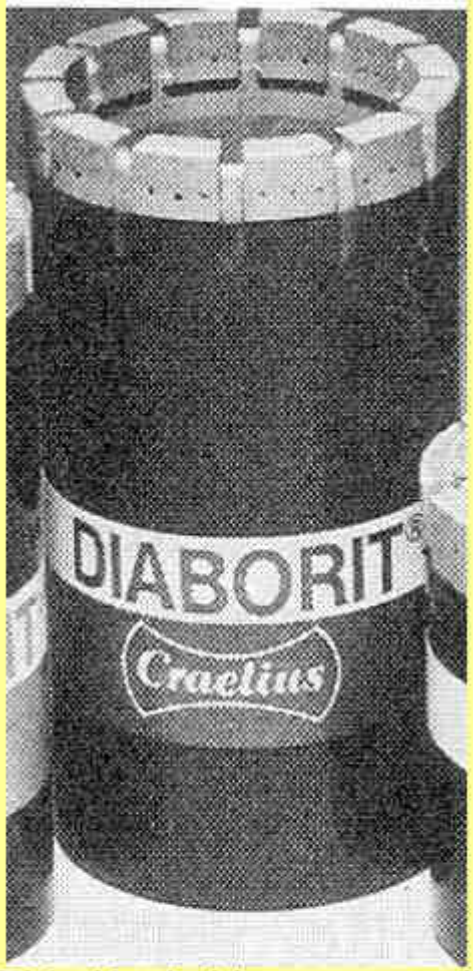
Types of Diamond Drilling Core Bits

Diamond Wireline Core Bits used in KTB-VB

Surface Set Diamond Bit

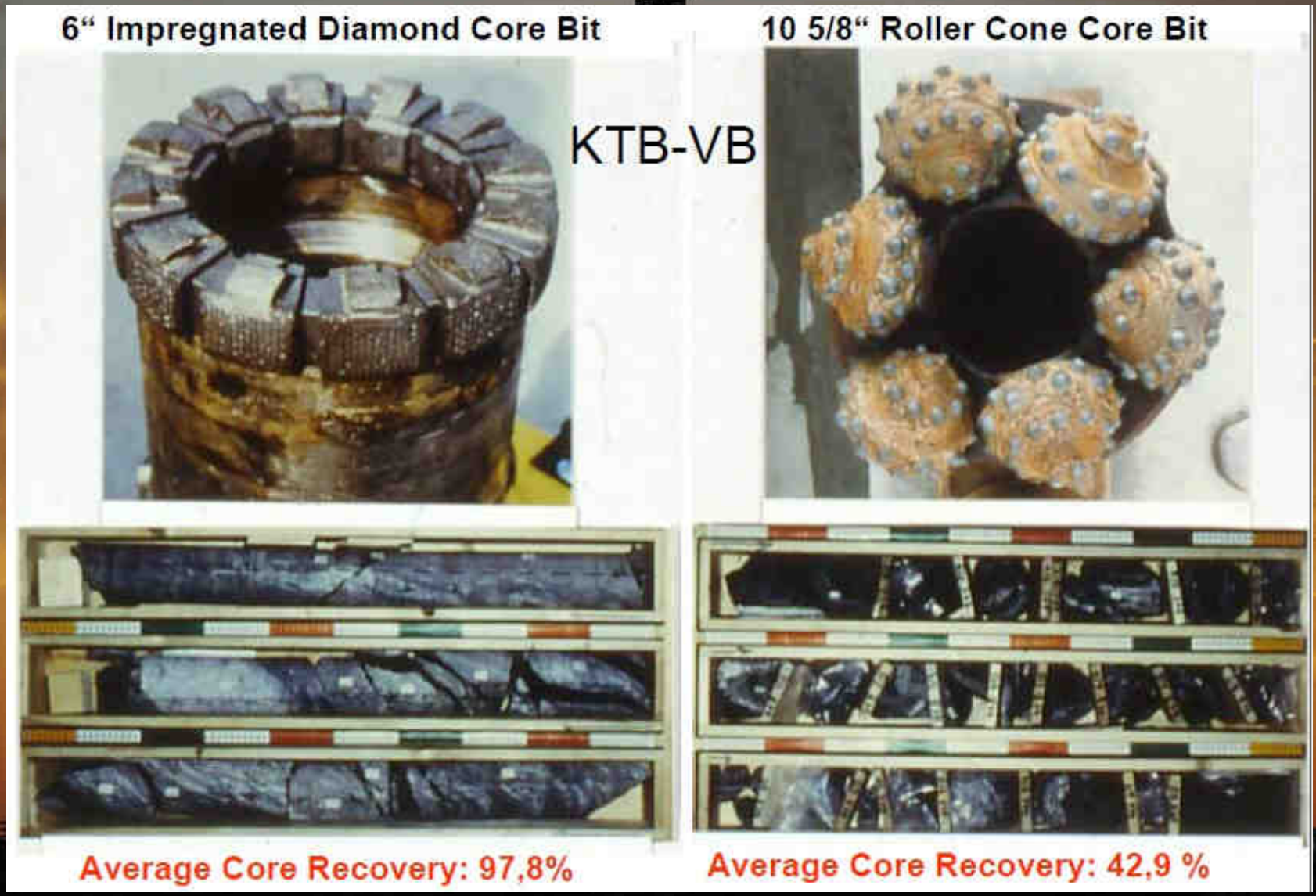
Impregnated Diamond Bit

No Wireline



Thin Kerfed Impregnated Diamond Core Bit

Performance of Core Bits in Crystalline Rock



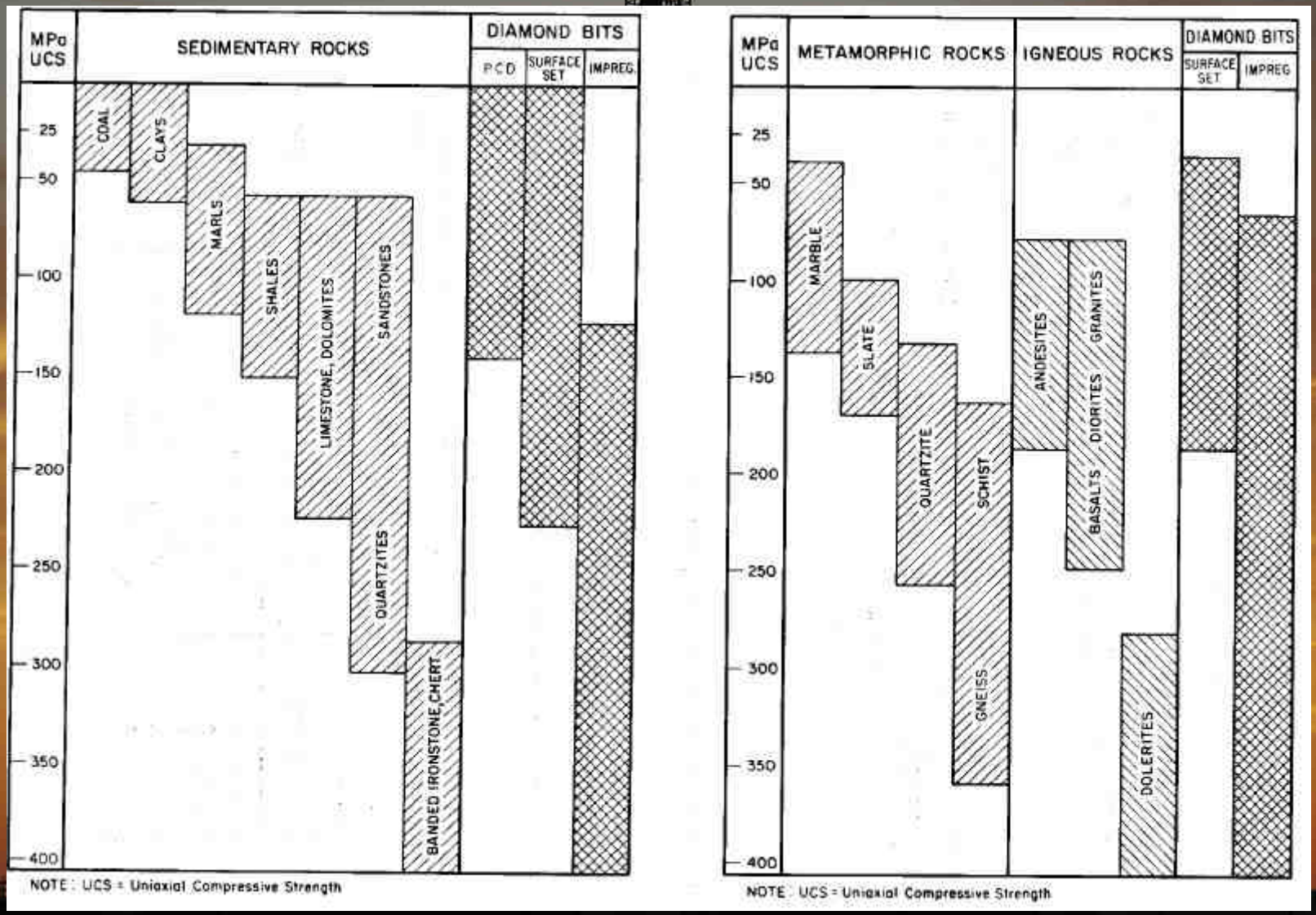
Large Diameter Diamond Coring in KTB Ultradeep Hole

12 ¼" Hole Section (6013 – 8328 m)

Large Diameter Core 9 ¼" (234,7 mm)

Core from KTB Pilot Hole

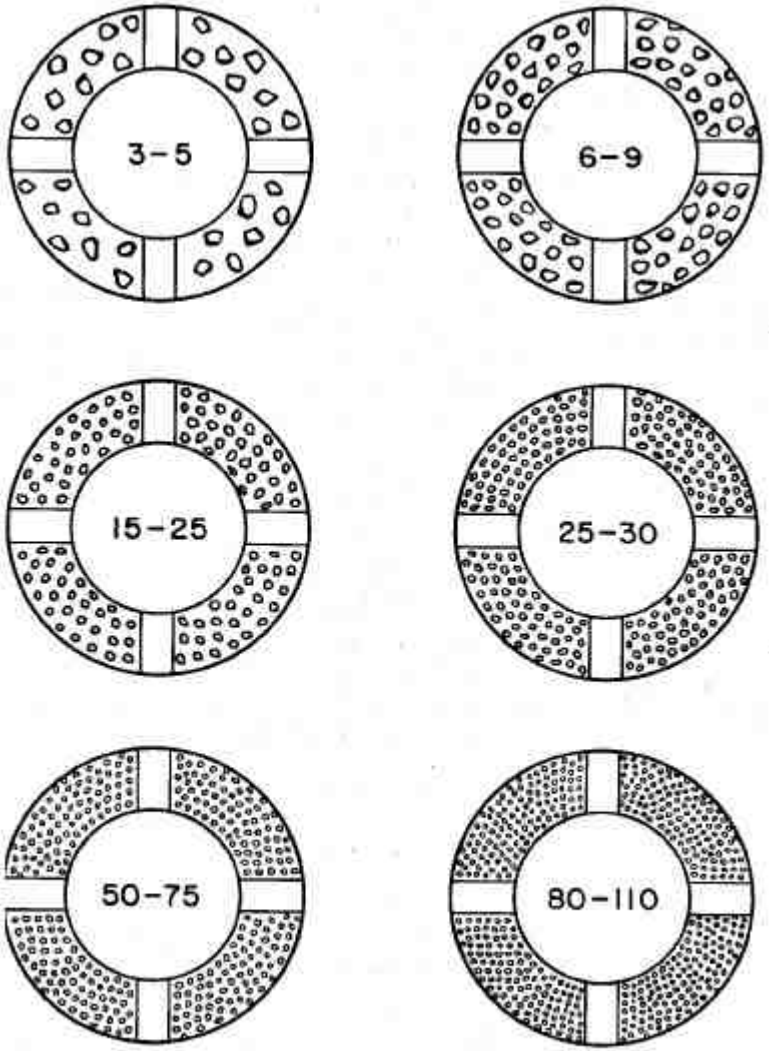
Diamond Bits Recommended for Various Rock Types



Recommended Diamond Stone Sizes for Various Rock Types

ROCK	4-8 SPC	20-30 SPC	60-80 SPC	80-110 SPC
SOFT SANDSTONE SHALE PLASTIC SHALE SOFT SCHIST				
HARD SCHIST DOLOMITE MARBLE ANDESITE				
GRANITE BASALT GABBRO				
CONGLOMERATE QUARTZITE CHERT				

SPC = Stone per Carat (0,2 g)



Set Pattern for Diamond Stones

Types of Core Barrels

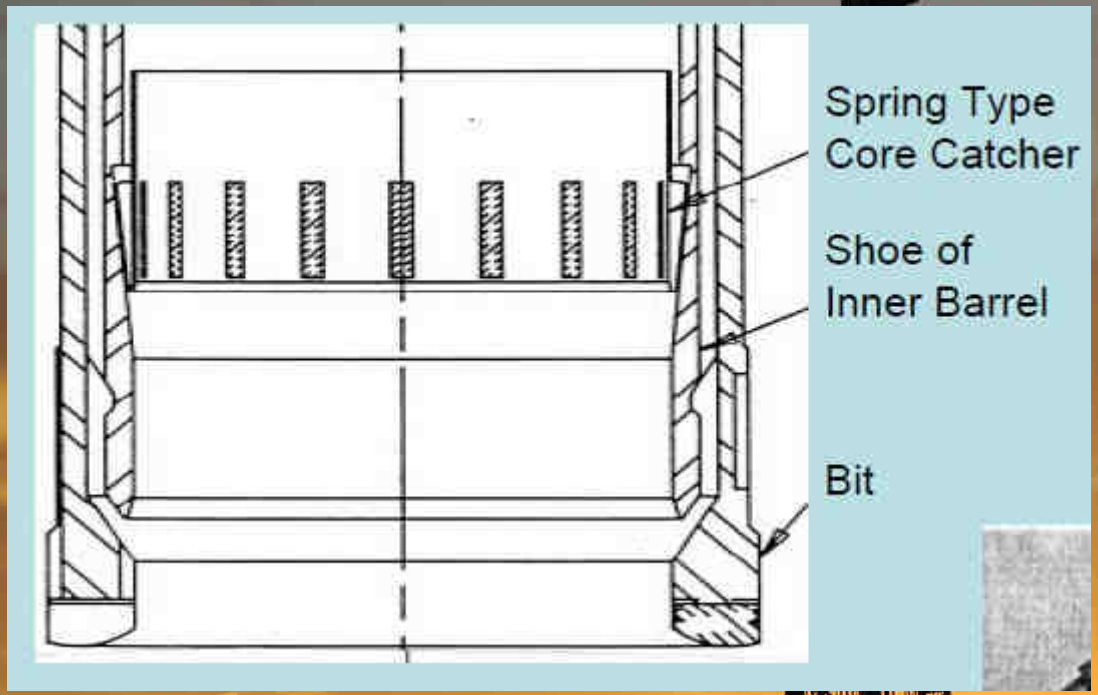
Core Barrel

- **Single Tube**
- **Double Tube**
  - **Rotating**
  - **Stationary**
    - ➢ Oilfield
    - ➢ Diamond Drilling
    - ➢ WL - Retrievable
    - ➢ Rubber Sleeve
    - ➢ Oriented

Main Components:

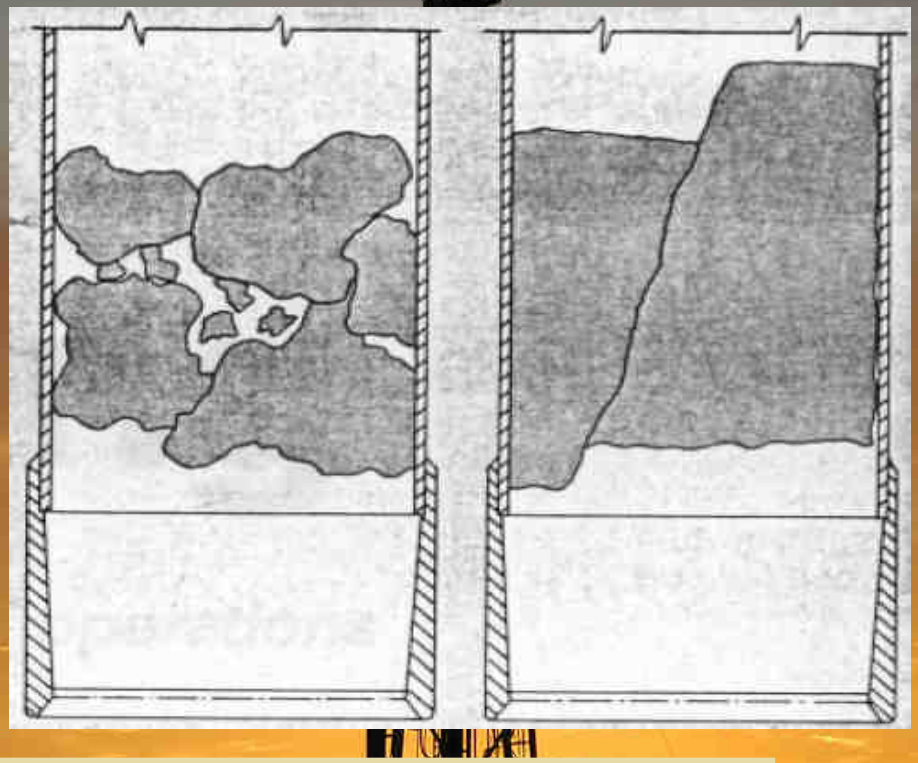
- outer core barrel
- inner core barrel
- core lifter /catcher
- thrust bearing
- ball valve

Schematic of Core Catcher



core is lifted after inner core barrel is filled by lifting the outer barrel which subsequently is transferred to the inner barrel (force for catching the core is supported by the outer barrel) wedging the core in the core lifter

Mechanism of Core Jamming

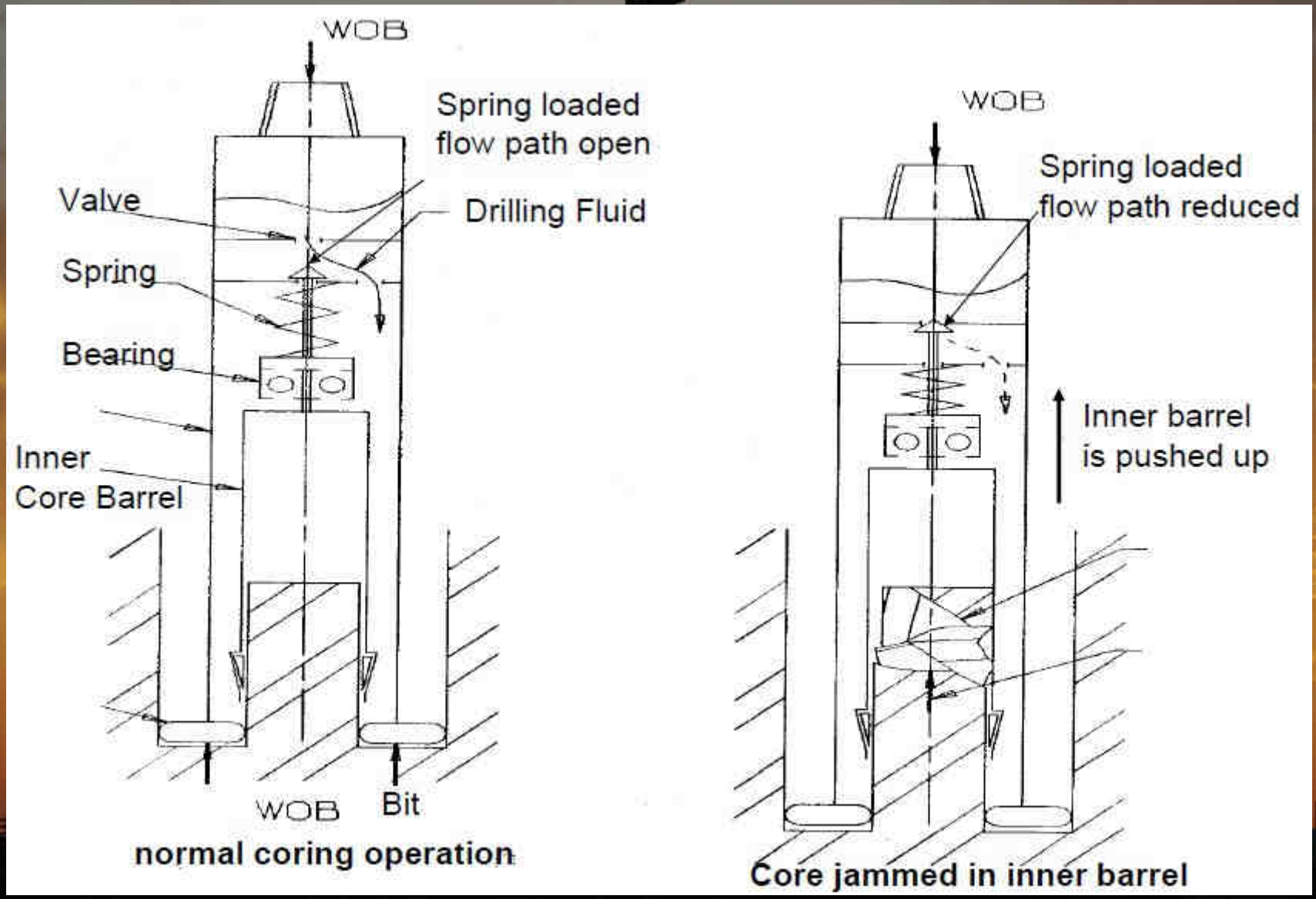


Consequences of Core Jamming:

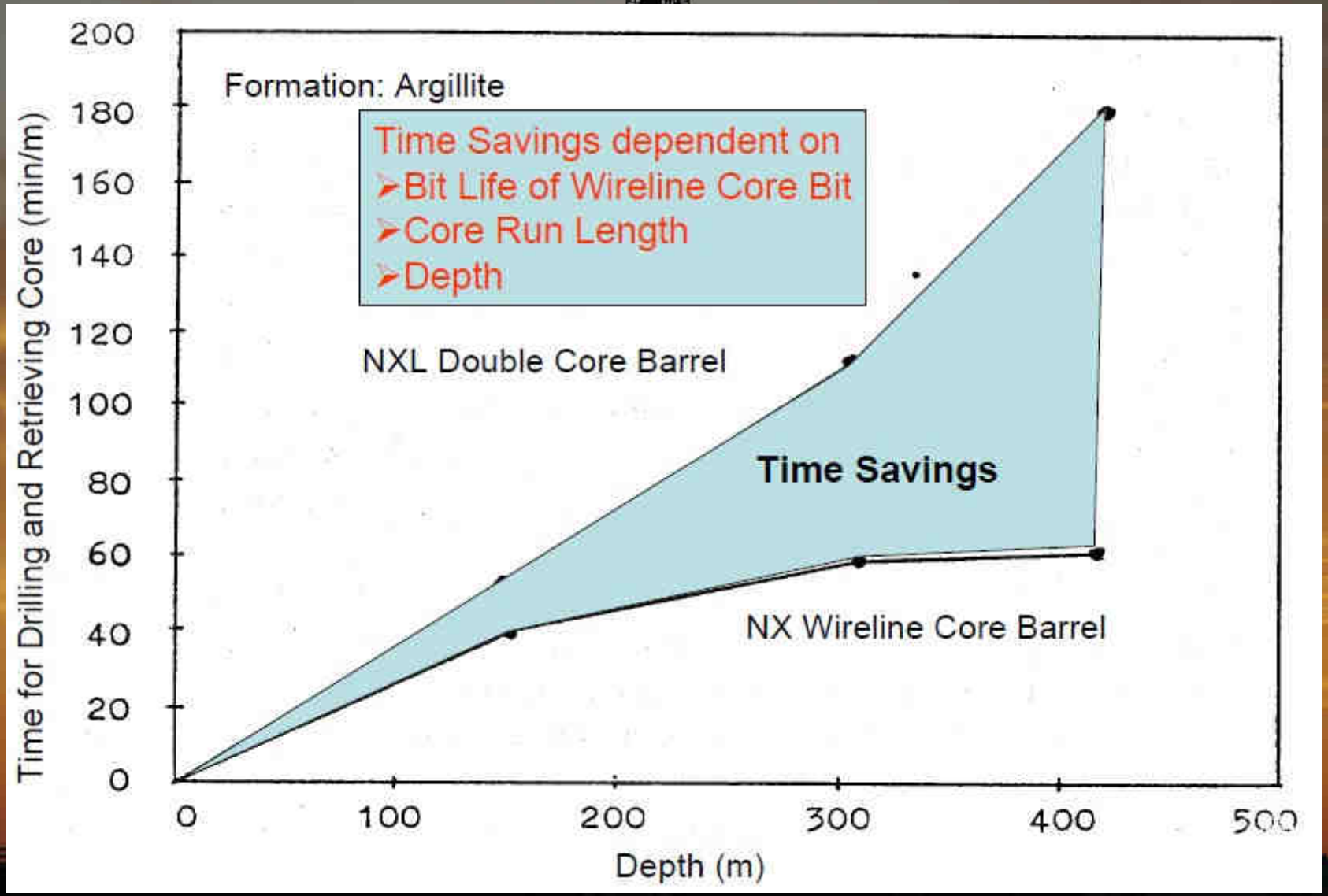
- **premature tripout of core barrel (additional roundtrip time)**
- **damage of core if not recognized**

CORE JAMMING INDICATOR

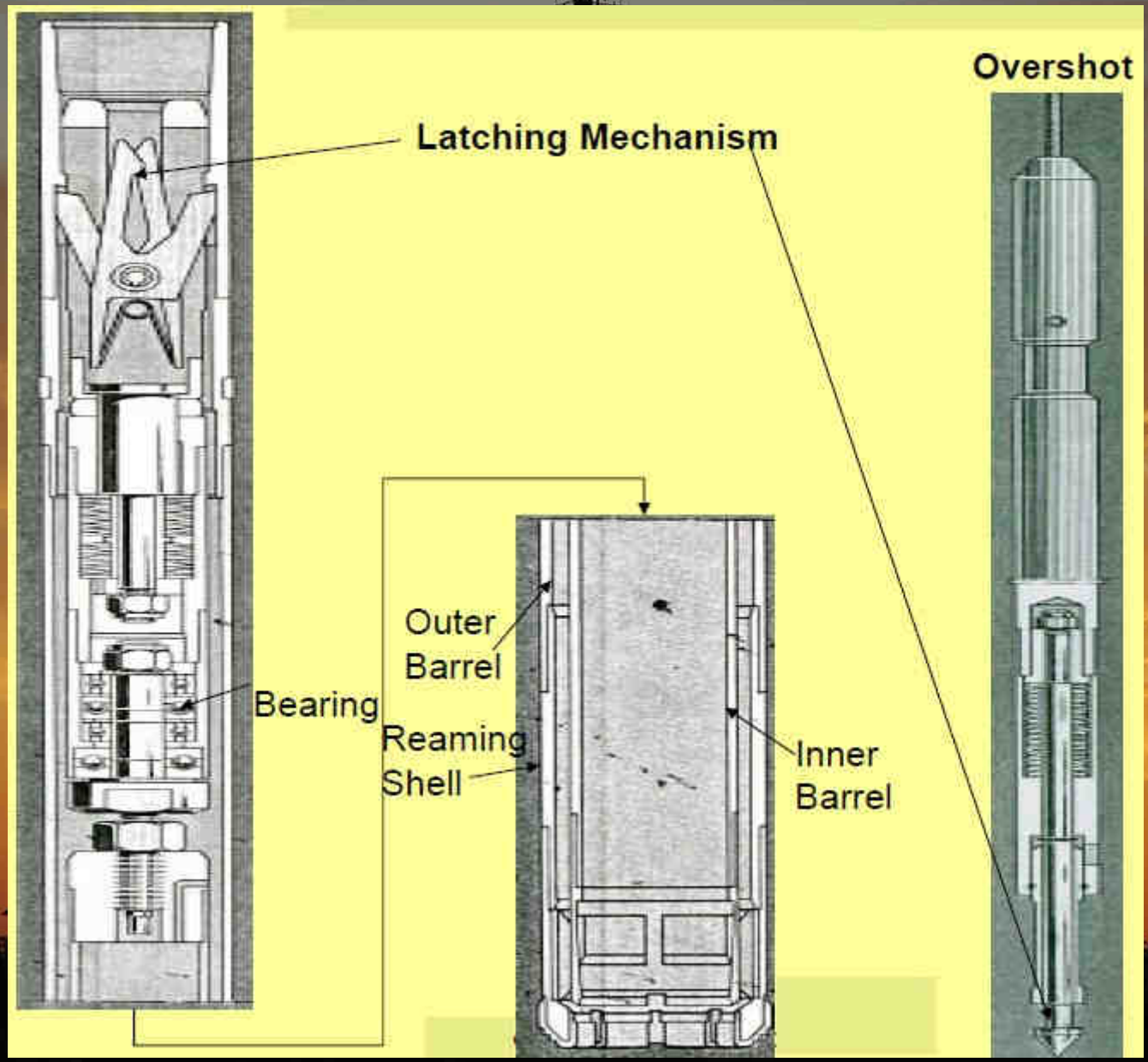
Mechanism of Core Jamming Indicator



Reasons for Wireline Coring



Schematic of Wireline Core Barrels



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