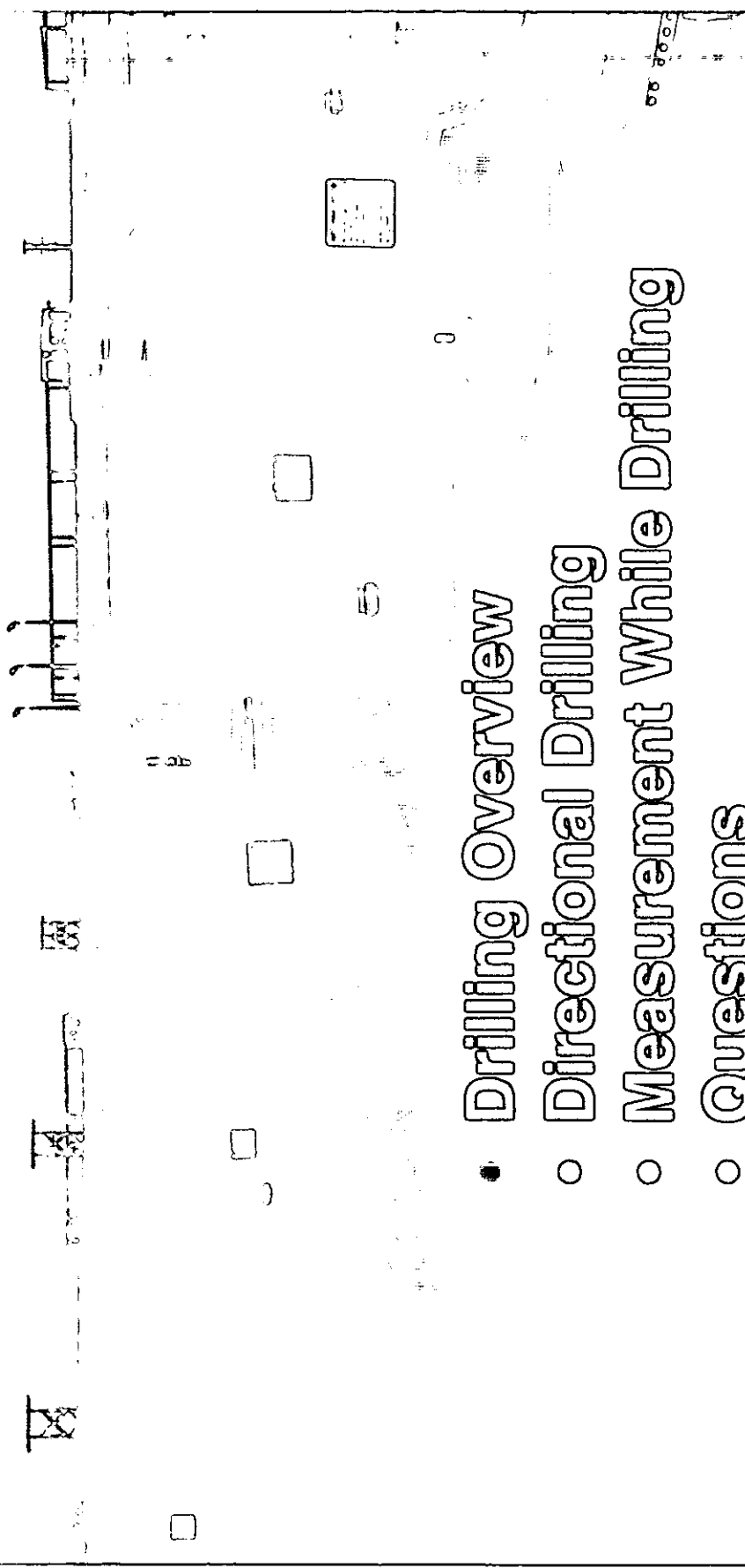


3/17/09
LUNCH &
LEARN:
DIRECTION-
AL
DRILLING

Harry Engel
Engineering Team Leader

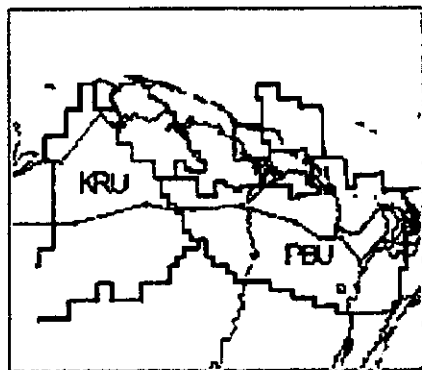
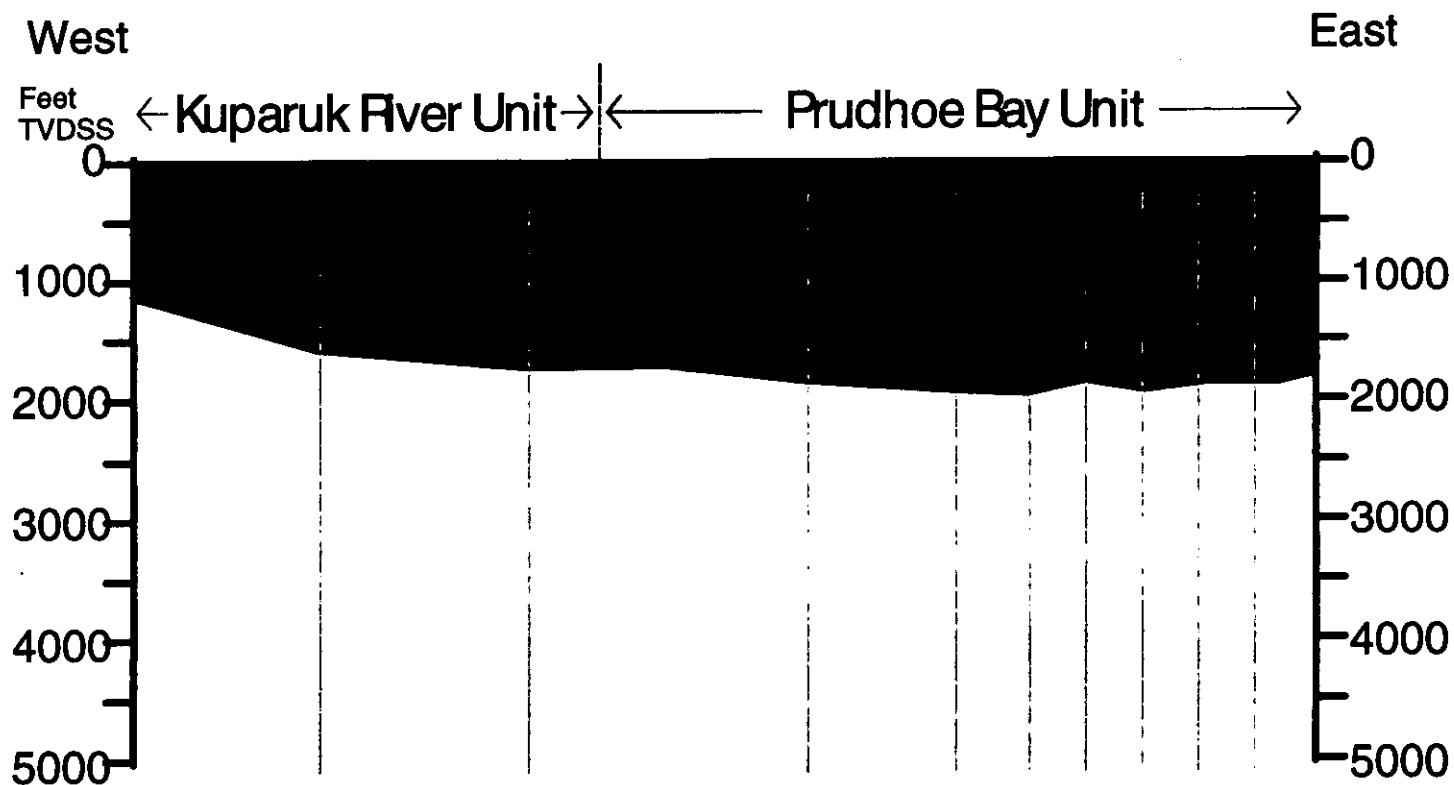
March 2009



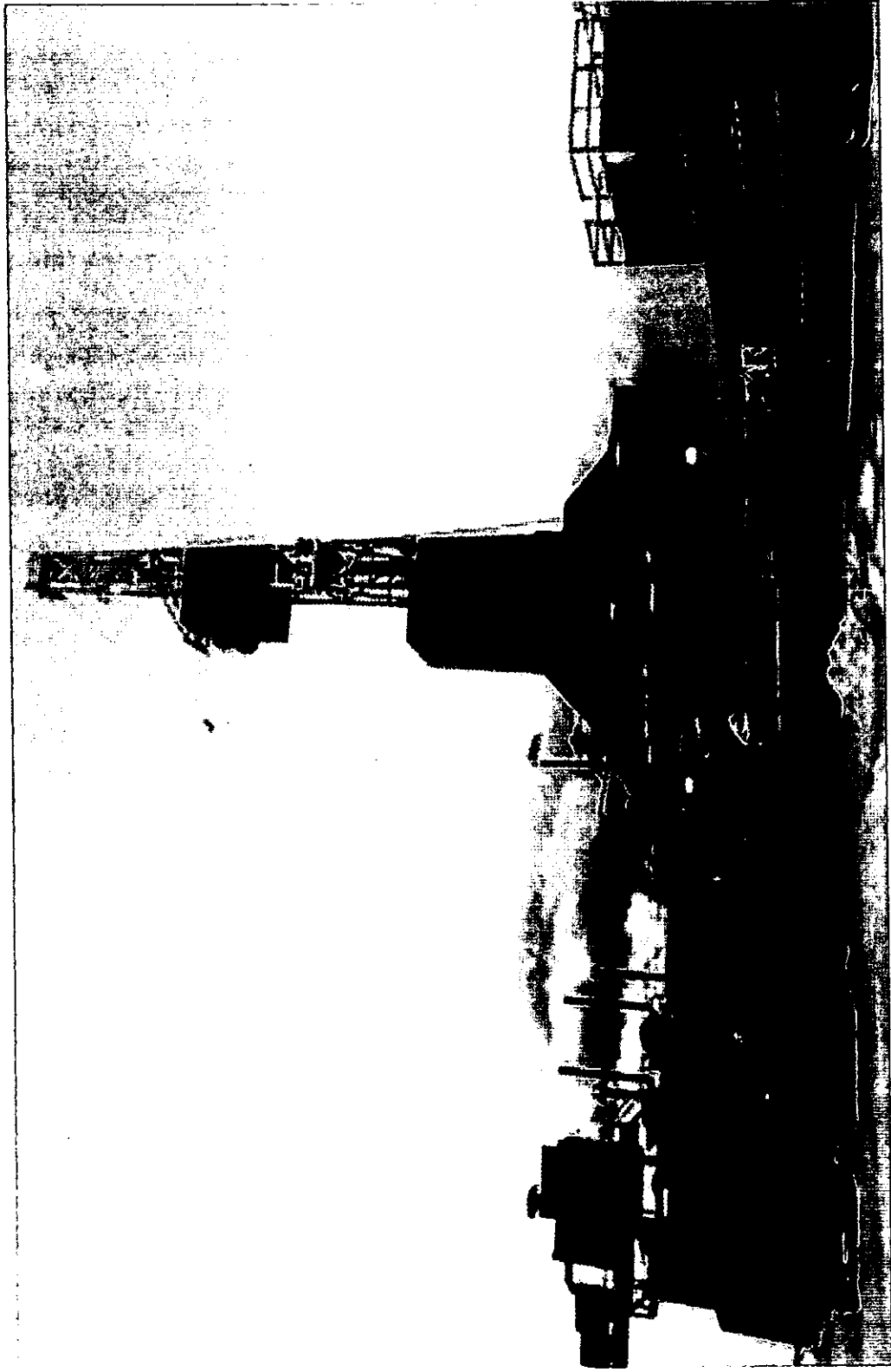


- Drilling Overview
- Directional Drilling
- Measurement While Drilling
- Questions

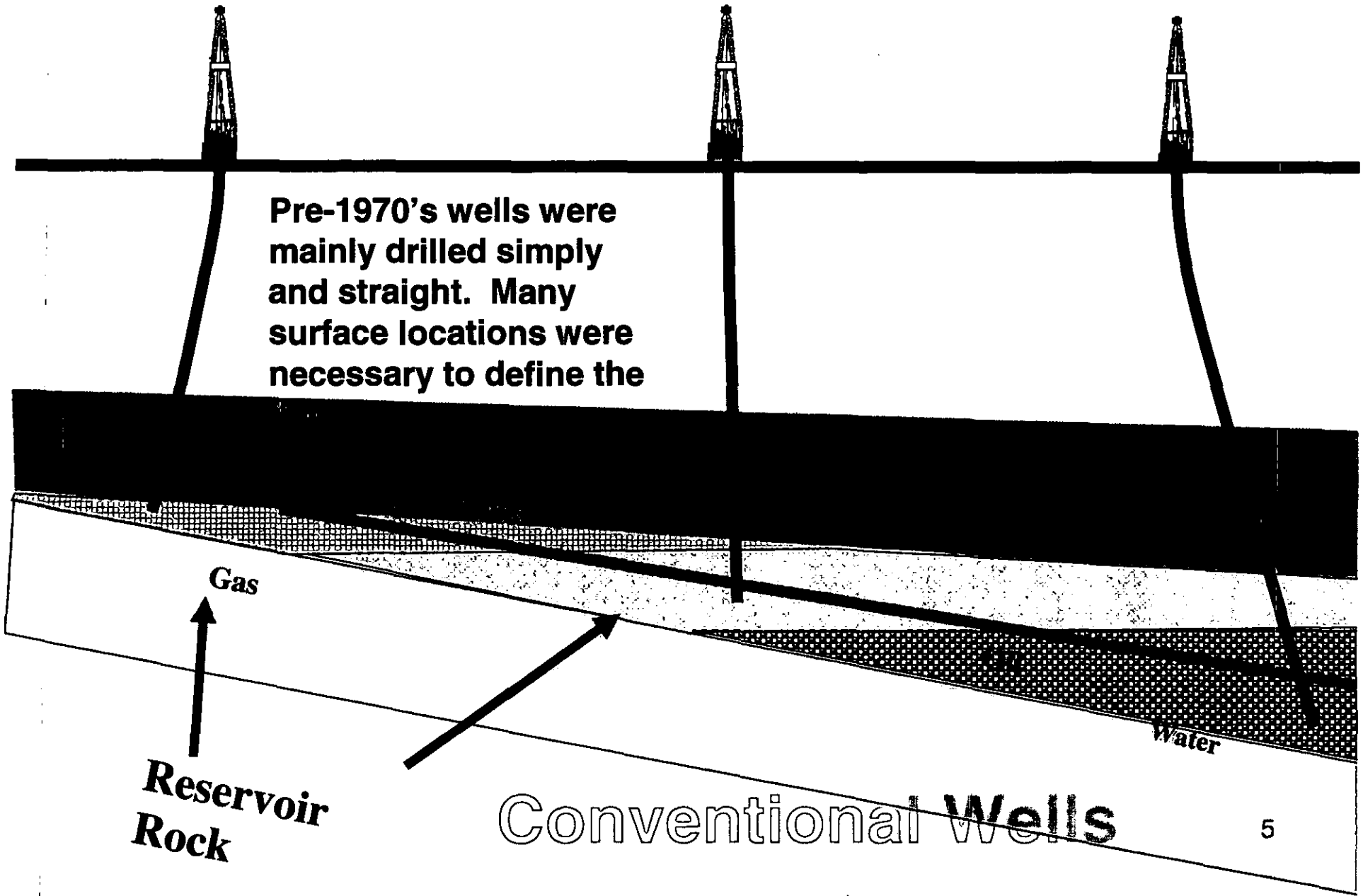
North Slope Permafrost



Typical Rotary Drilling Rig

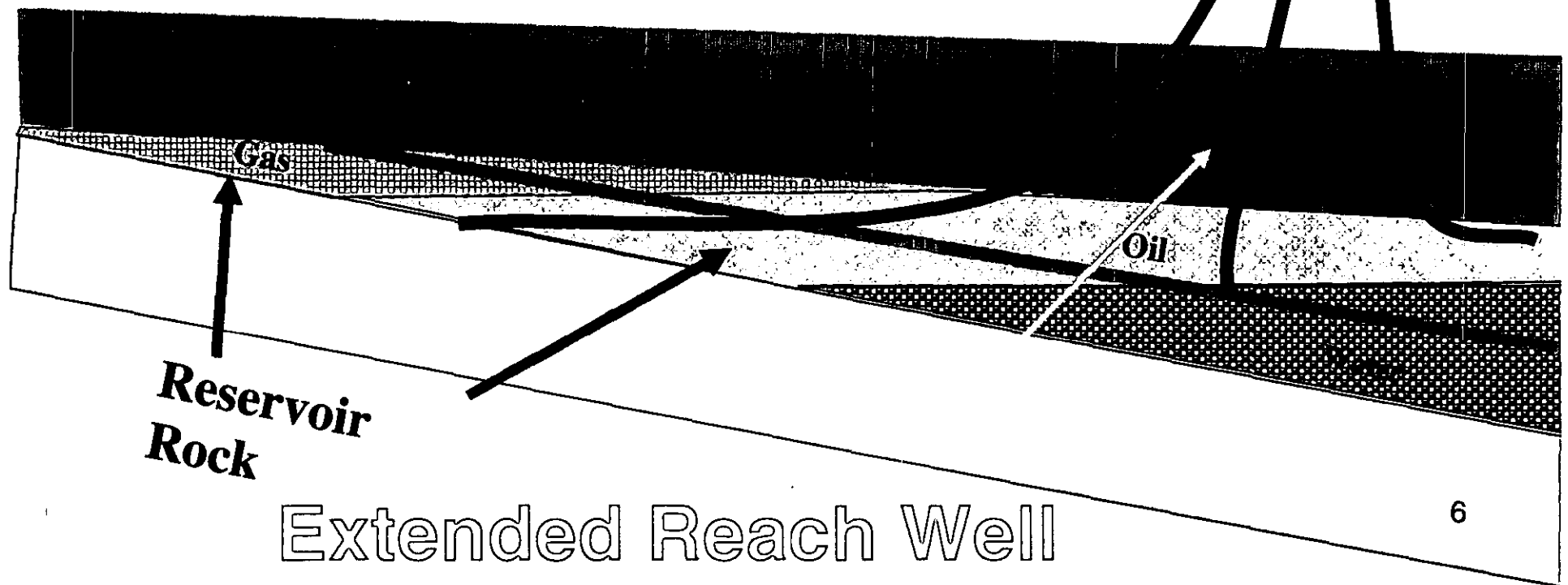


WELL CONSTRUCTION



WELL CONSTRUCTION

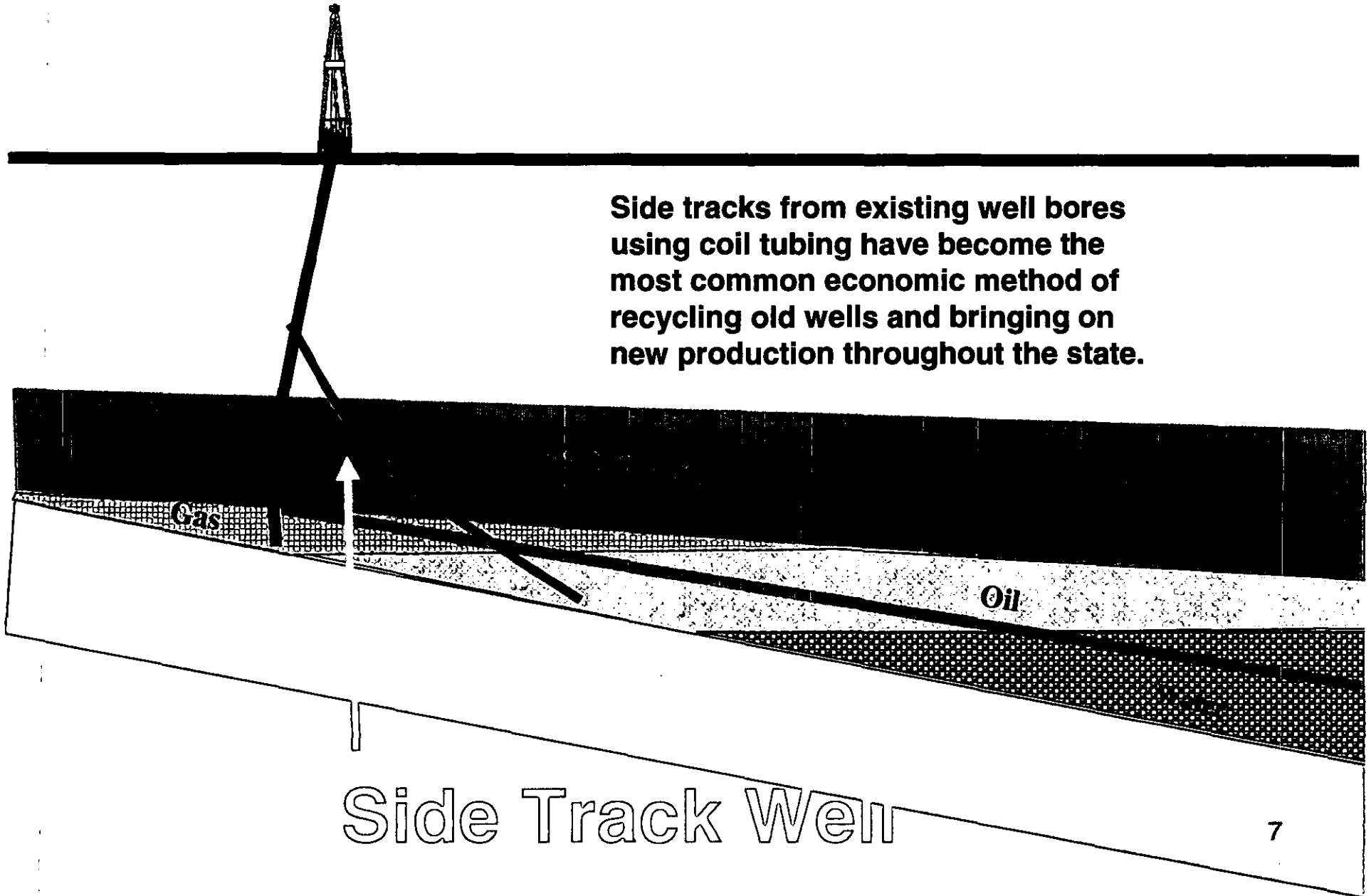
Extended reach wells were developed to access reservoirs from fewer, smaller locations such as offshore platforms and in environmentally sensitive areas to minimize surface disruption.



Extended Reach Well

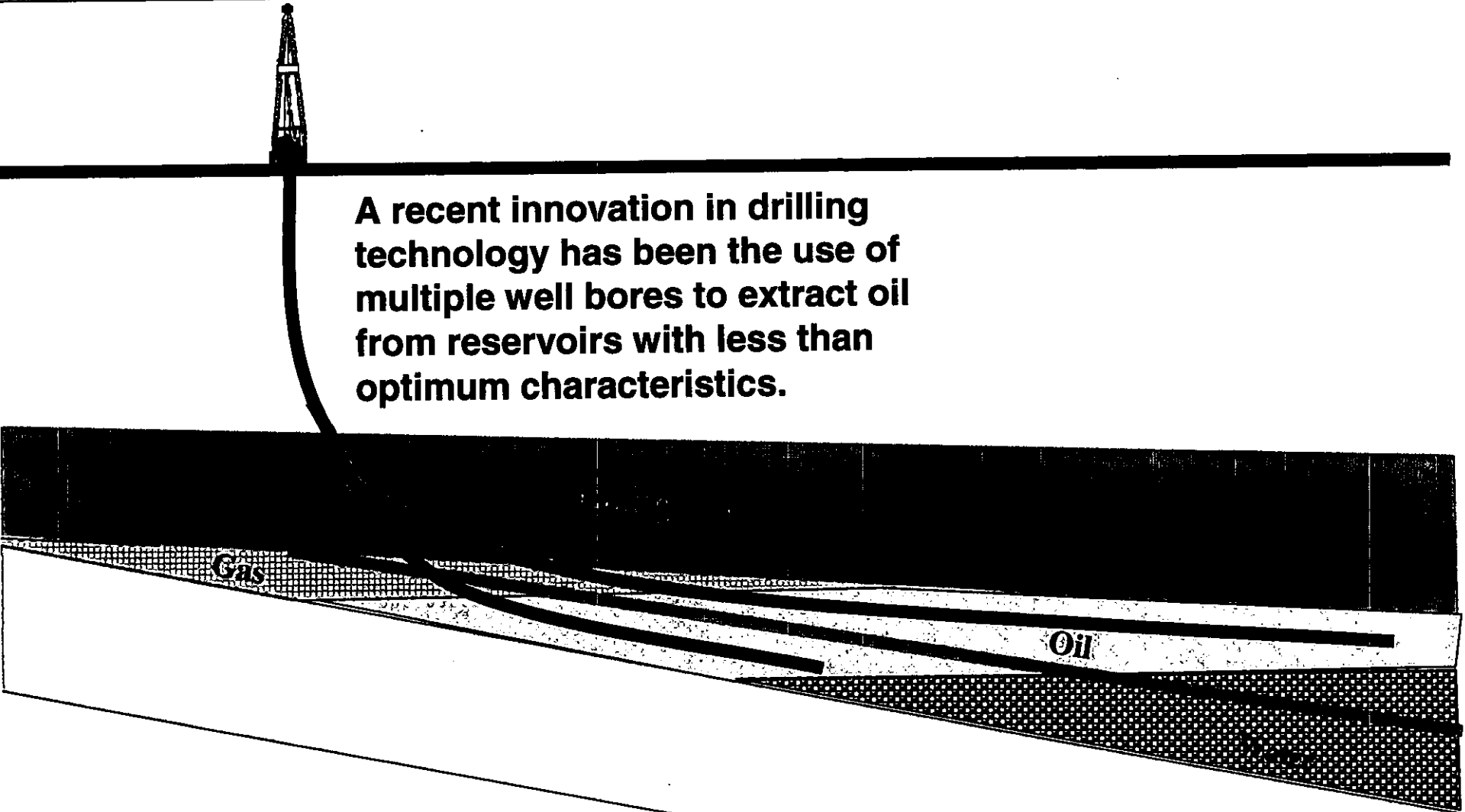
WELL CONSTRUCTION

Side tracks from existing well bores using coil tubing have become the most common economic method of recycling old wells and bringing on new production throughout the state.



Side Track Well

WELL CONSTRUCTION

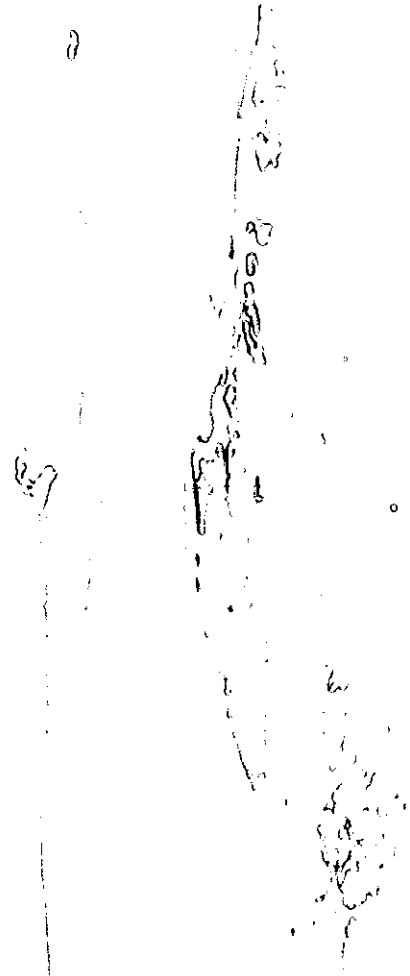


A recent innovation in drilling technology has been the use of multiple well bores to extract oil from reservoirs with less than optimum characteristics.

Multi-Lateral Well

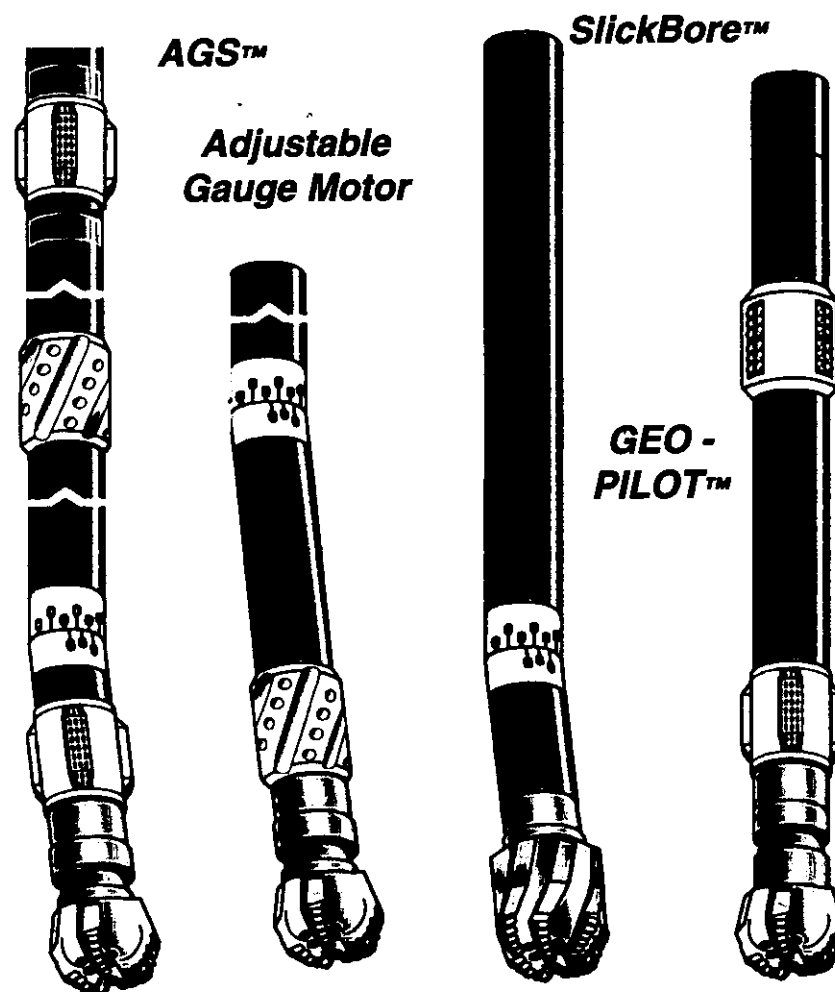
Directional Drilling

- Technology allows efficient resource development
- Minimize surface foot print
- Pinpoint reservoir target
- Surveying underground...angle, direction and distance
- Downhole computers send survey data to the surface



How do we “Directionally Drill”?

- Directional Drilling Systems
 - Mud Motors
 - Rotary Steerable Tools



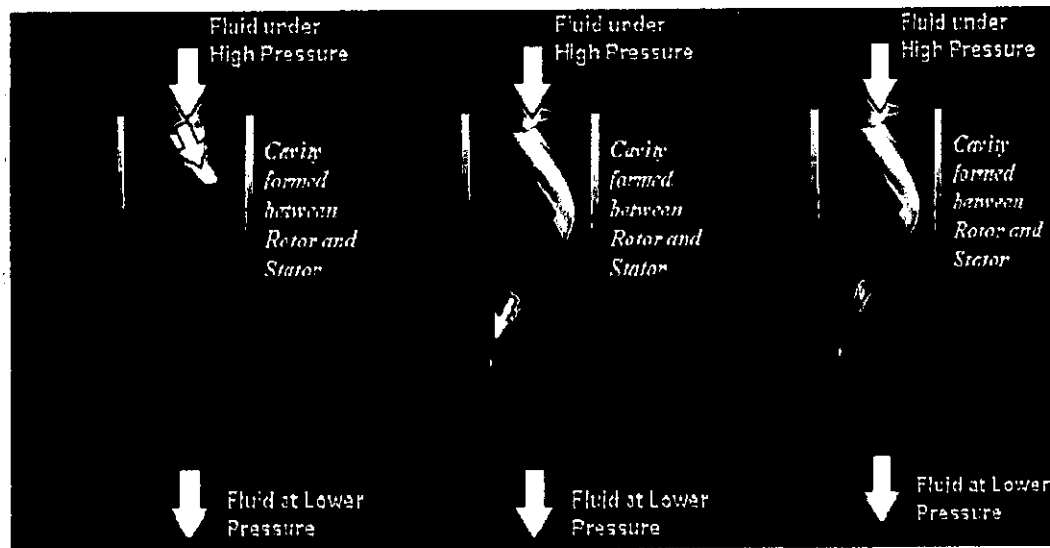
Mud Motor - Rotor



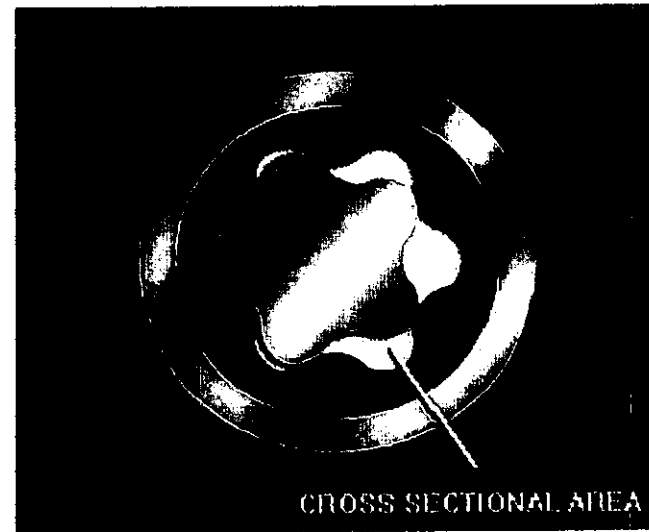
Mud Motor – Stator Cross Section



How the Motor Works?

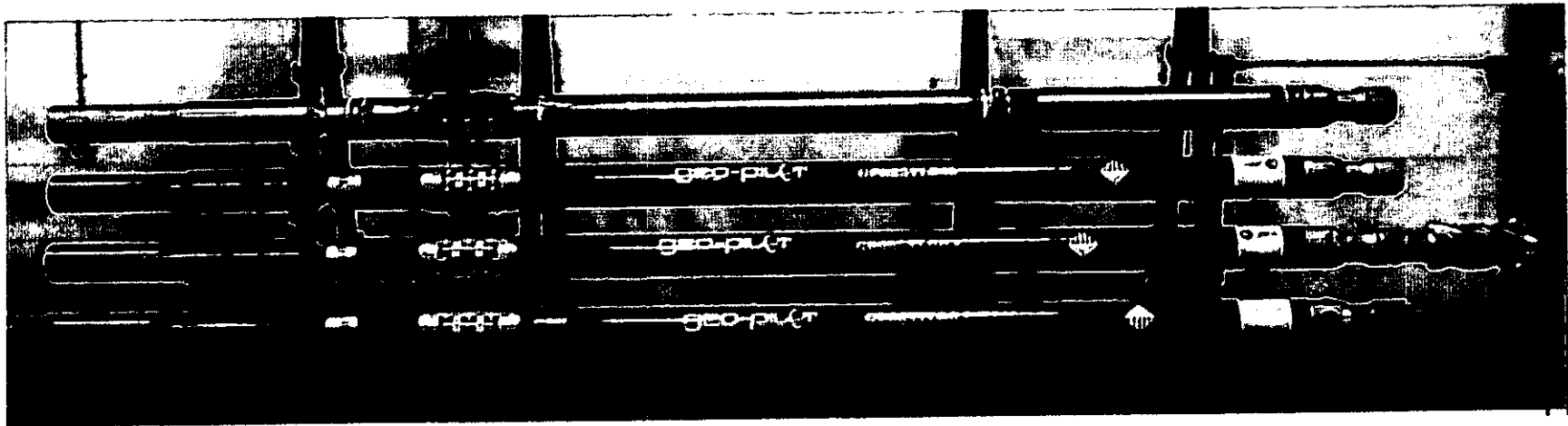


The differential pressure causes drilling fluid to enter the cavities at the top of the motor. As it moves through the motor, the fluid pushes on the rotor causing it to rotate.



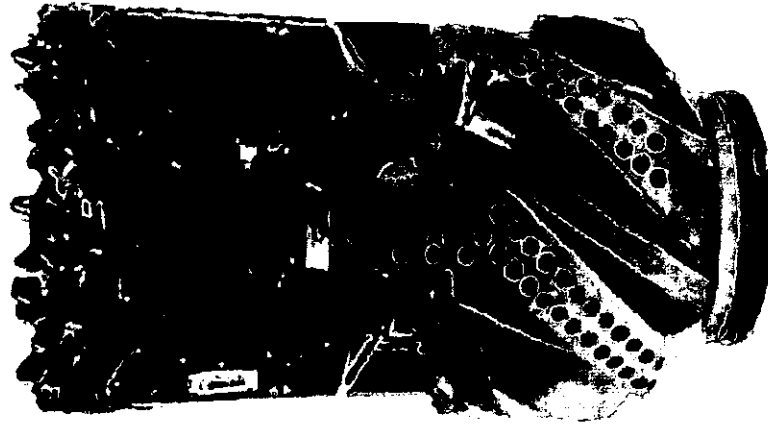
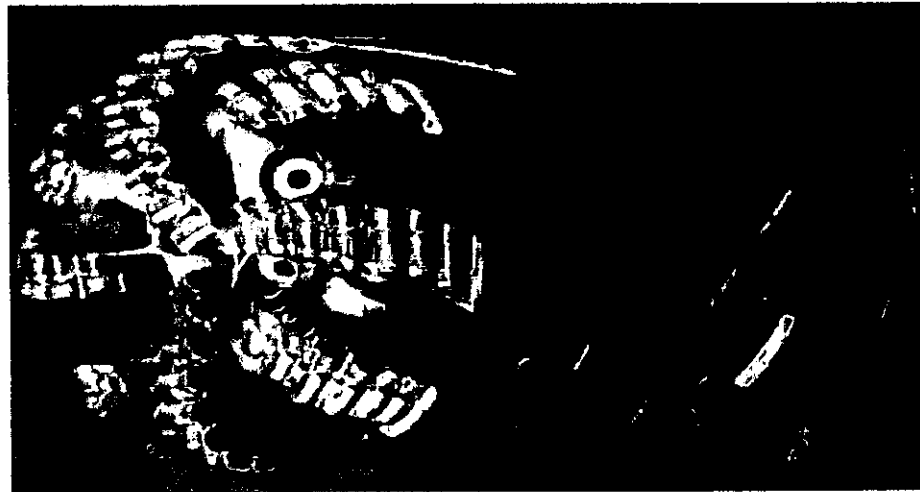
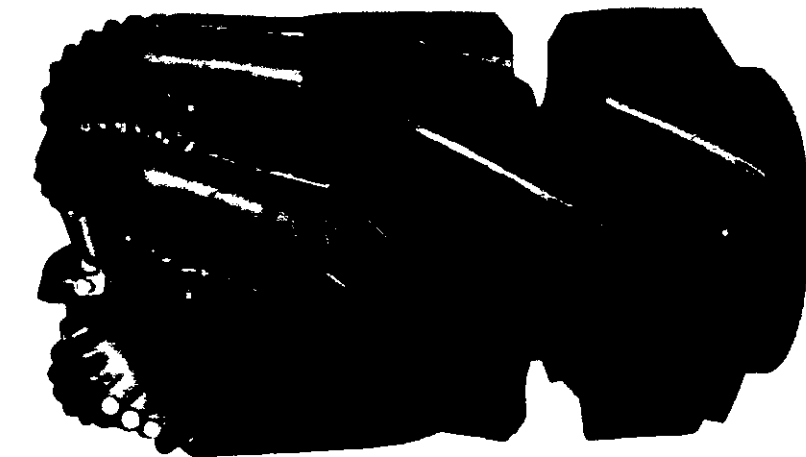
Rotary Steerable System

- Rotation comes from the rig at surface
- Drill Faster – Higher Overall Rate of Penetration due to:
 - Less friction, lower drag due to rotating 100% of the time
 - Less time spent cleaning hole
 - Fewer sticking pipe incidences
- Drill Farther – Beyond the technical limit of Mud Motors



Rotary Steerable Bits – Long

Gauge



Measurement While Drilling (MWD)

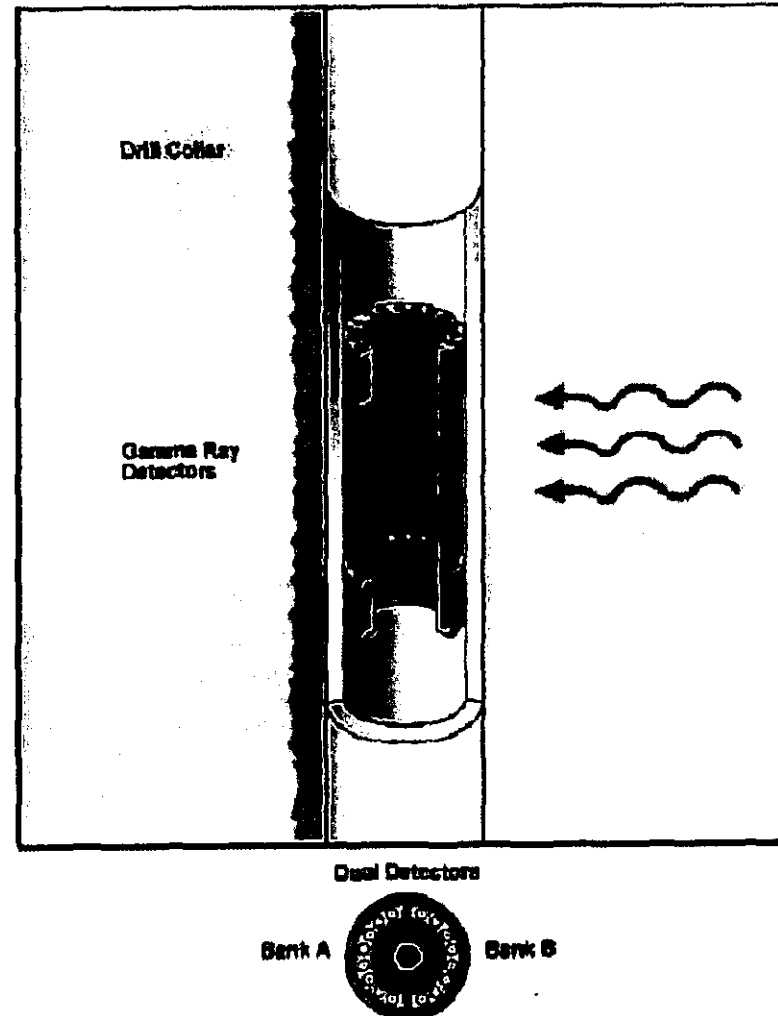
How do we know what is happening 2 miles below ground?

Basic MWD sensors and Mud Pulse Telemetry

- Gamma Ray Sensor
- Resistivity Sensor
- MWD Pulser

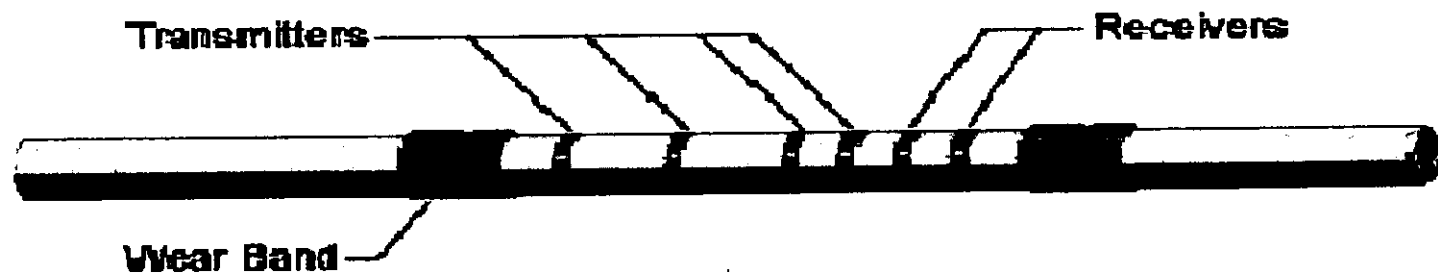
Gamma Ray Tool

- Measure background Gamma Radiation
- Lets you know if you drilling in a shale or sand
- Does not tell you if your in a oil bearing sand – Other tools are used in conjunction to answer that



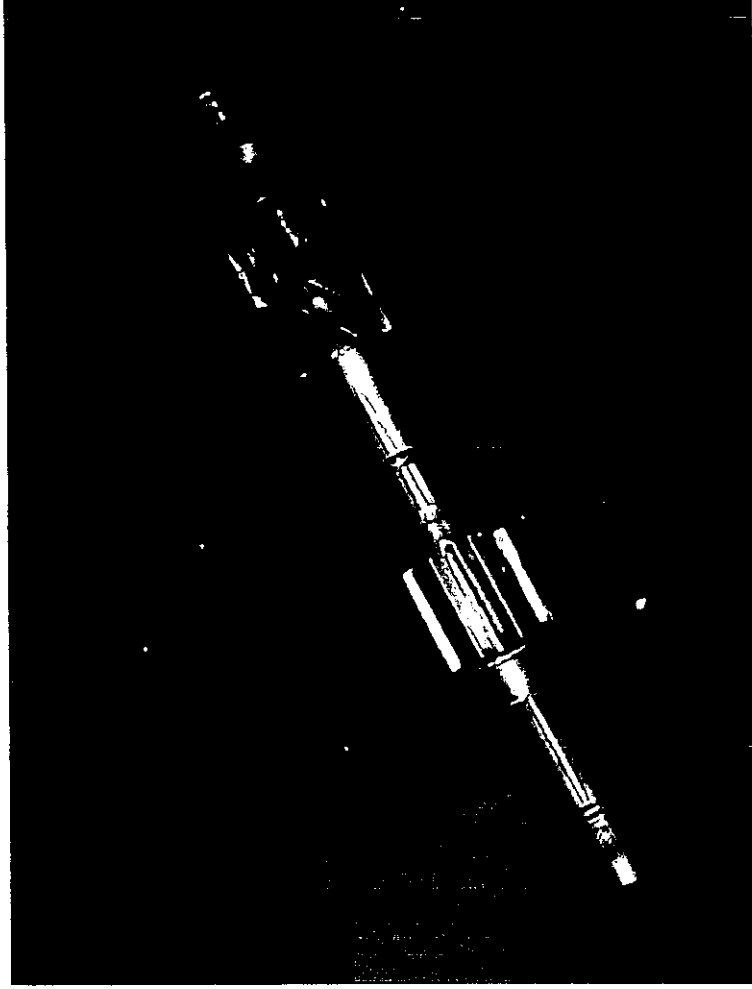
Resistivity Tool

- Tell you if your drilling through a formation with electrically conductive or insulating substance
 - Oil does not conduct electricity – High Resistivity readings
 - Water conducts electricity – Low Resistivity readings
- Think of it as sending out radio waves with receivers set at different distances



MWD Pulsar

- **Electrical Generator**
 - Supplies Power to all MWD tools below ground
- **Transfers all the data to the surface**

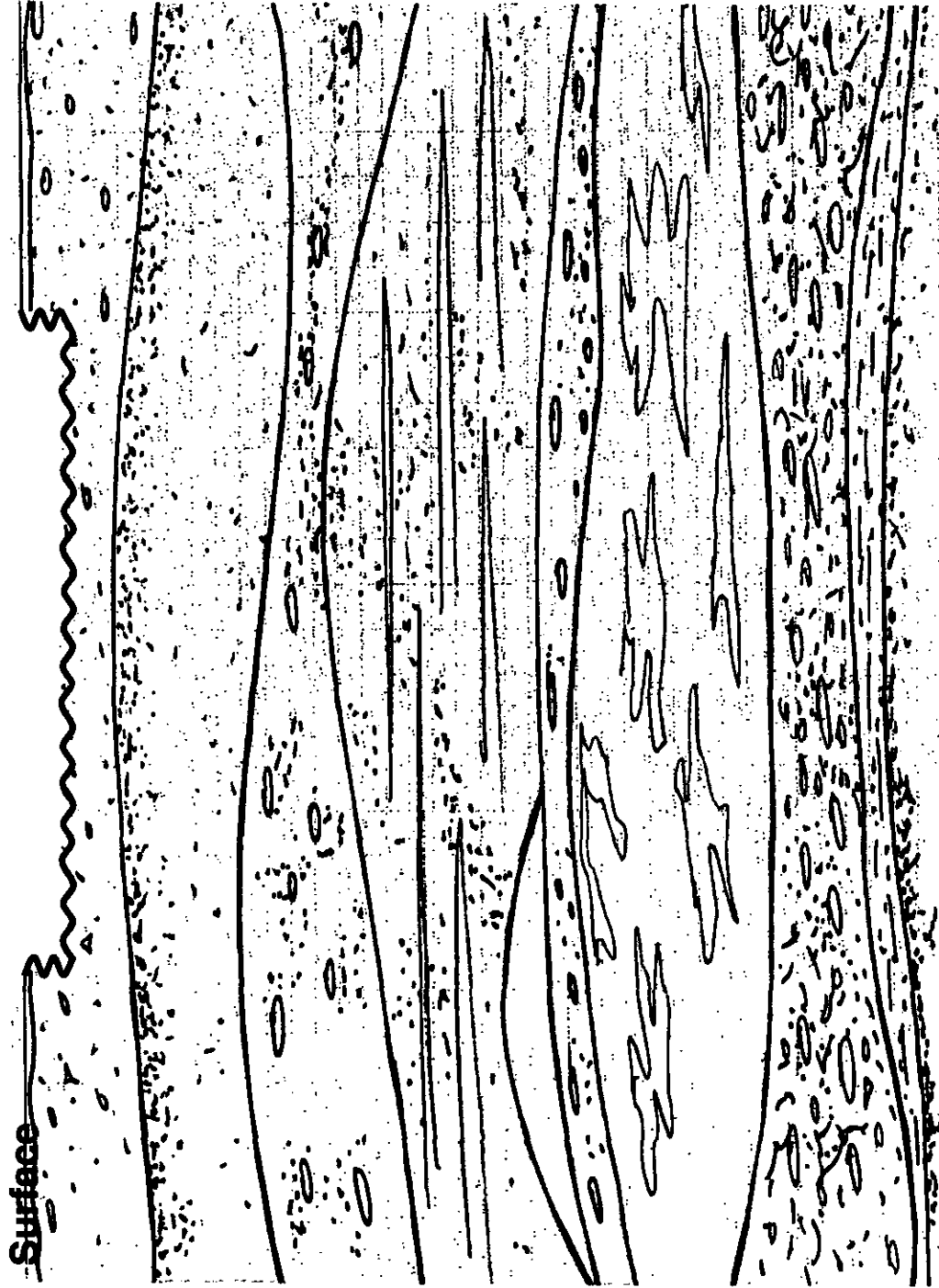


Main steps to drill a well

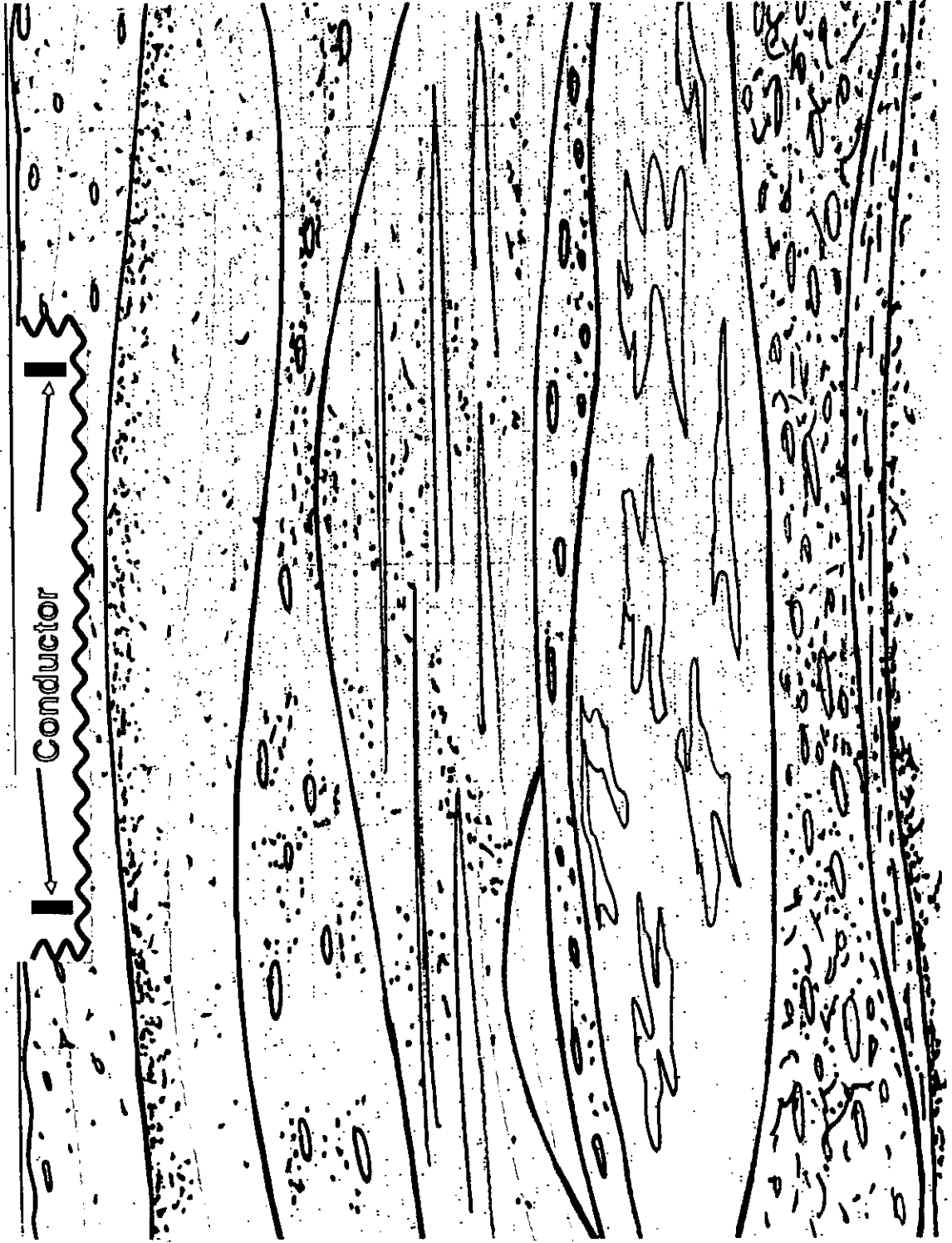
- Drill the interval of interest.
- Acquire geological and reservoir information.
- Run casing over the interval.
- Cement the interval.
- Pressure test the cemented casing.
- Start over again...

WELL CONSTRUCTION

CONDUCTOR HOLE DRILLED

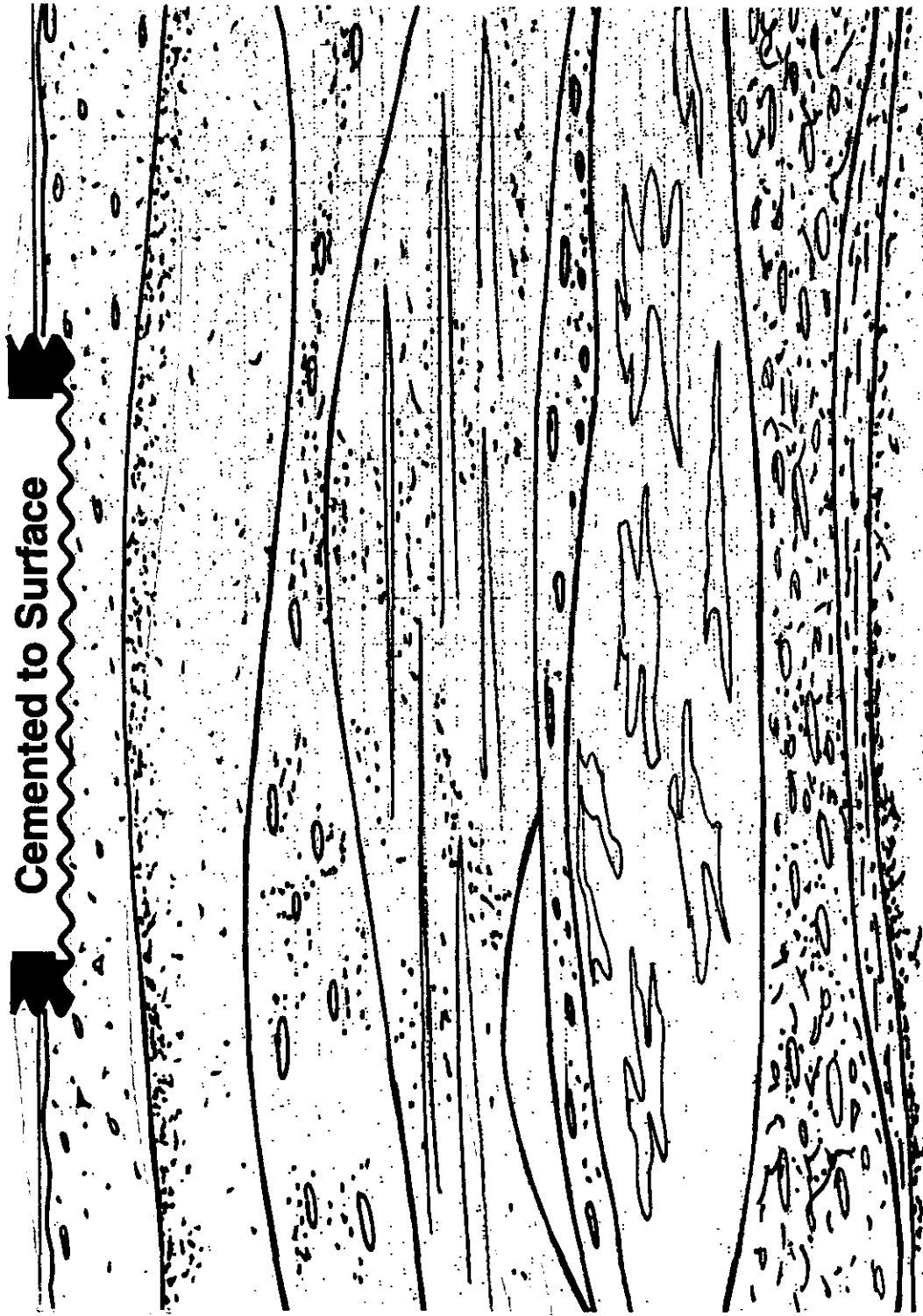


WELL CONSTRUCTION



WELL CONSTRUCTION

CONDUCTOR PIPE CEMENTED

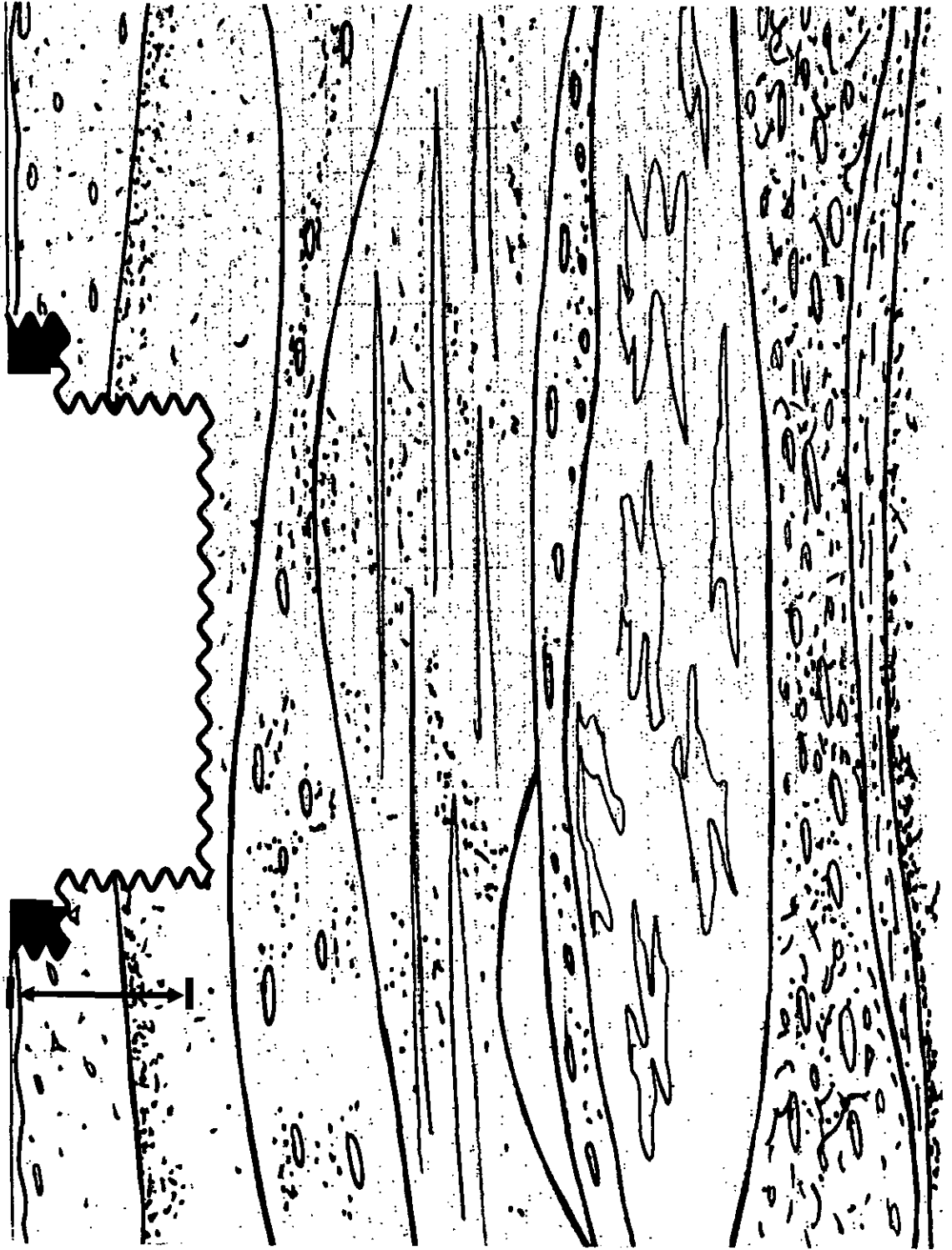


WELL CONSTRUCTION



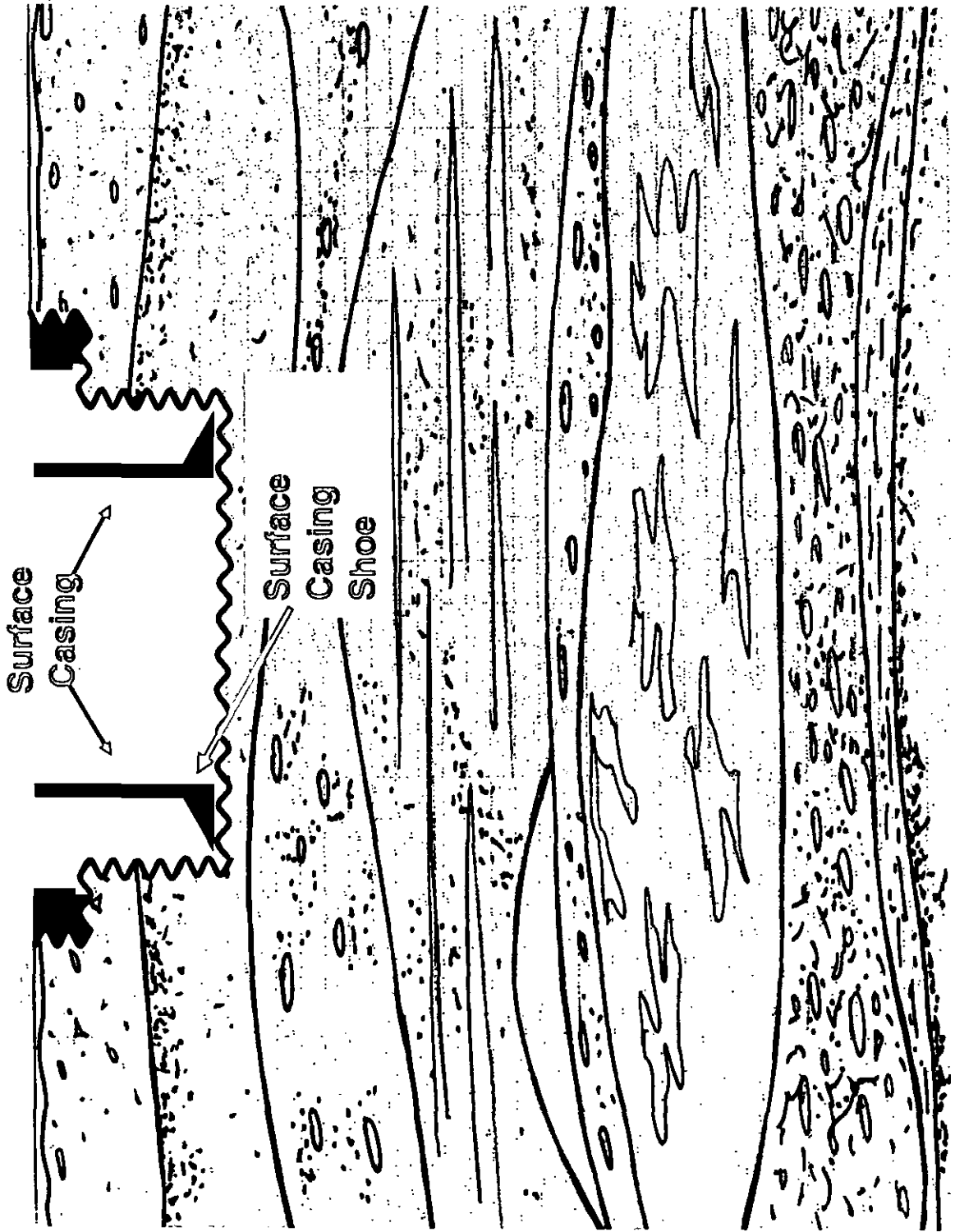
WELL CONSTRUCTION

SURFACE HOLE DRILLED



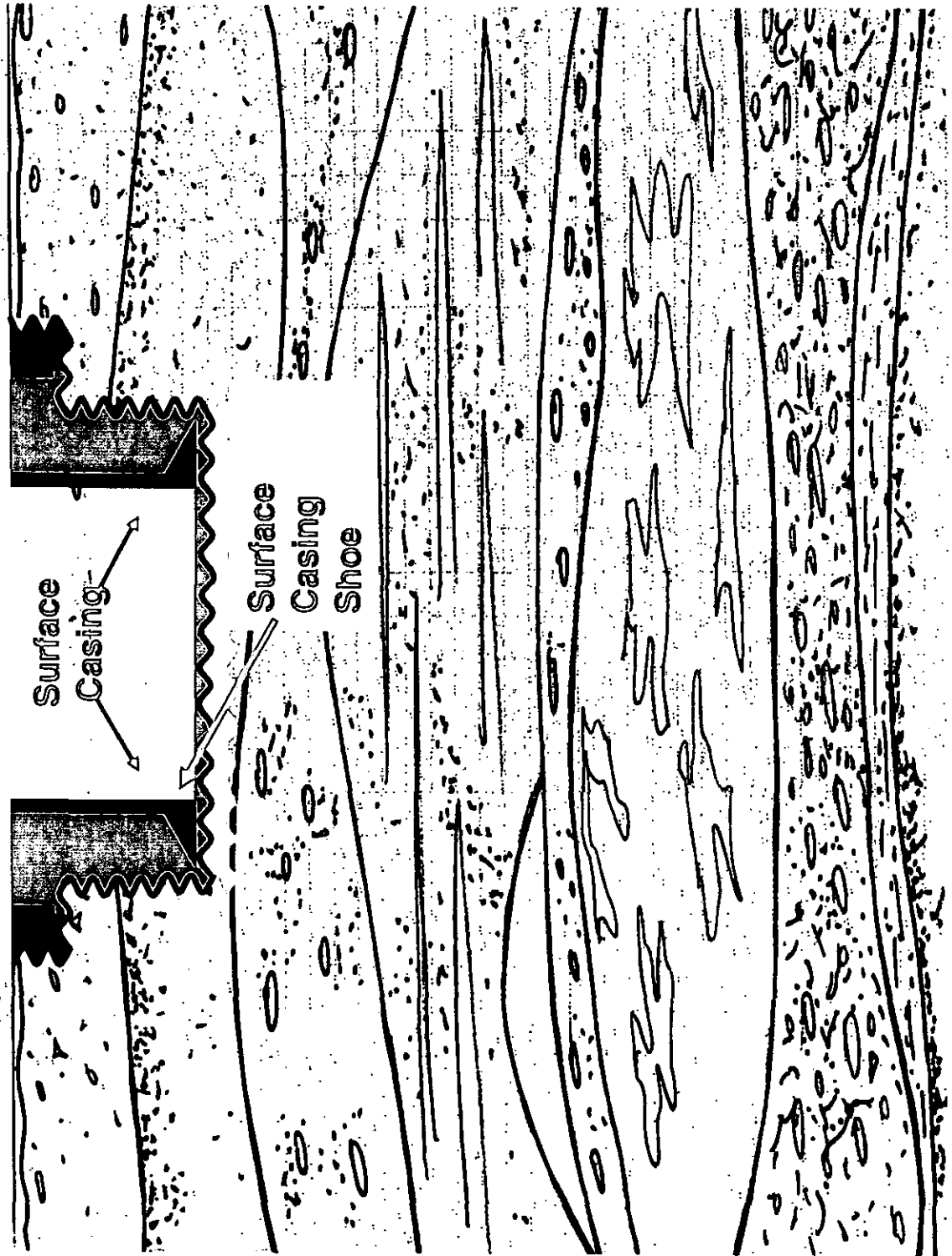
WELL CONSTRUCTION

SURFACE CASING RUN



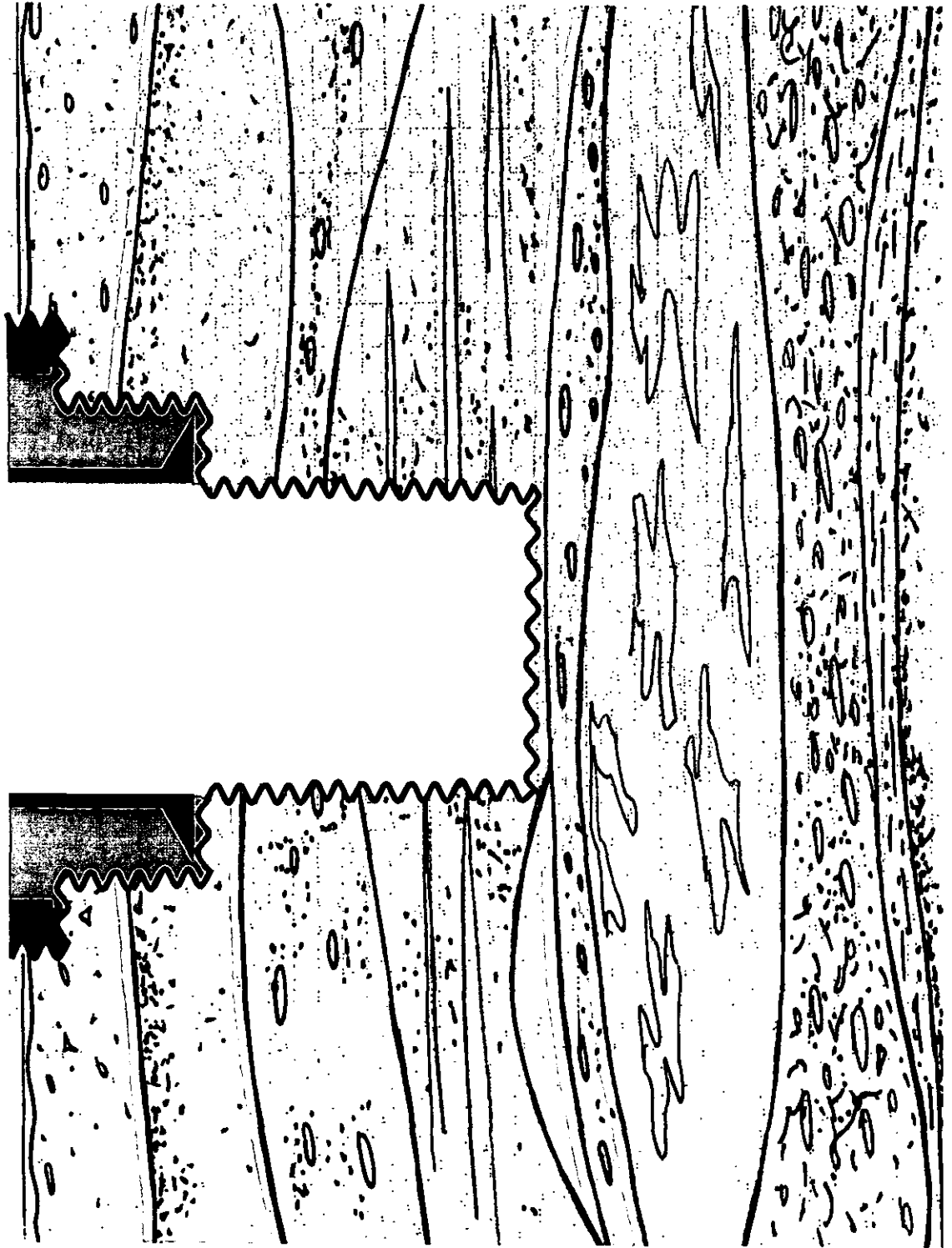
WELL CONSTRUCTION

SURFACE CASING CEMENTED TO SURFACE



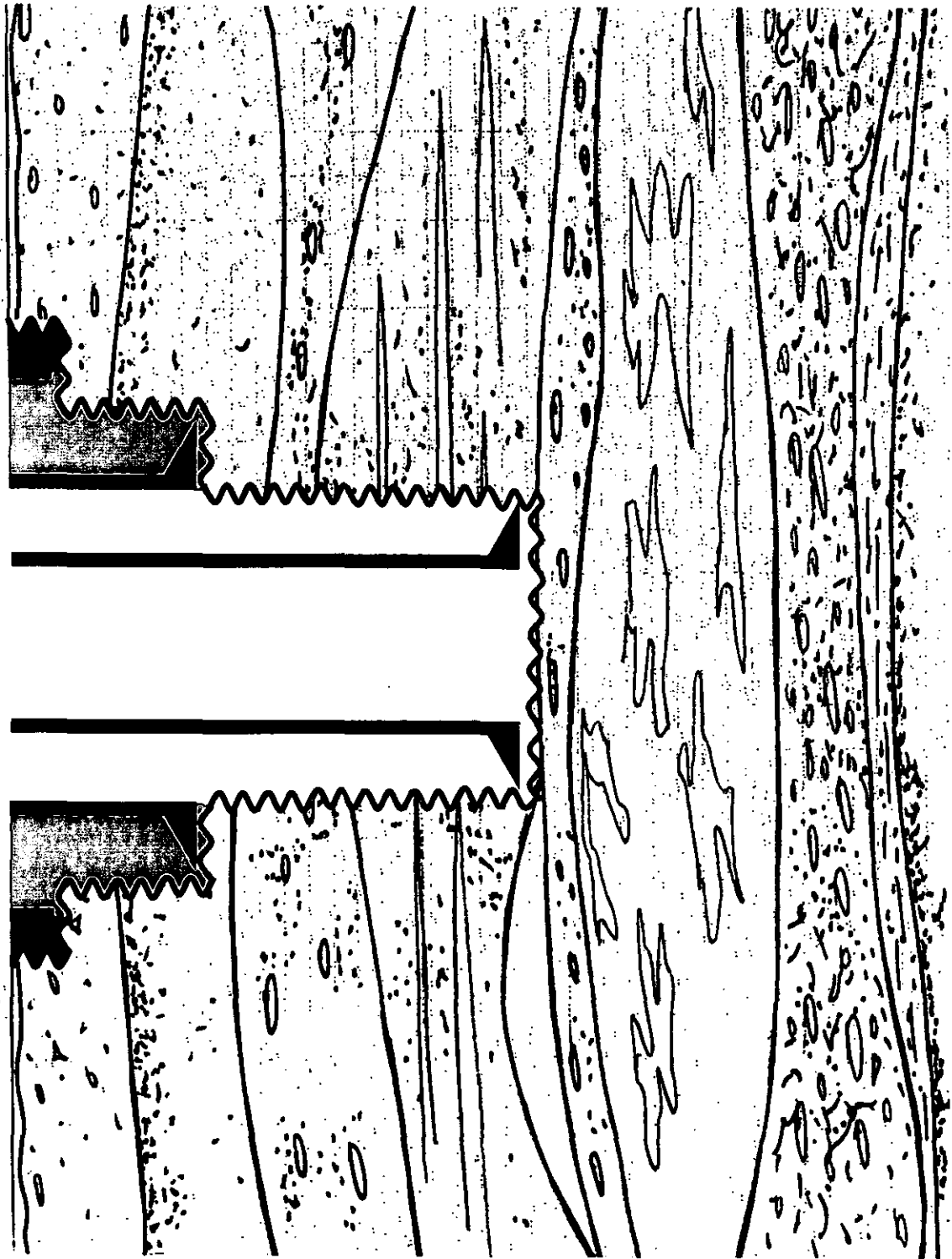
WELL CONSTRUCTION

REMAINDER OF INTERMEDIATE HOLE DRILLED



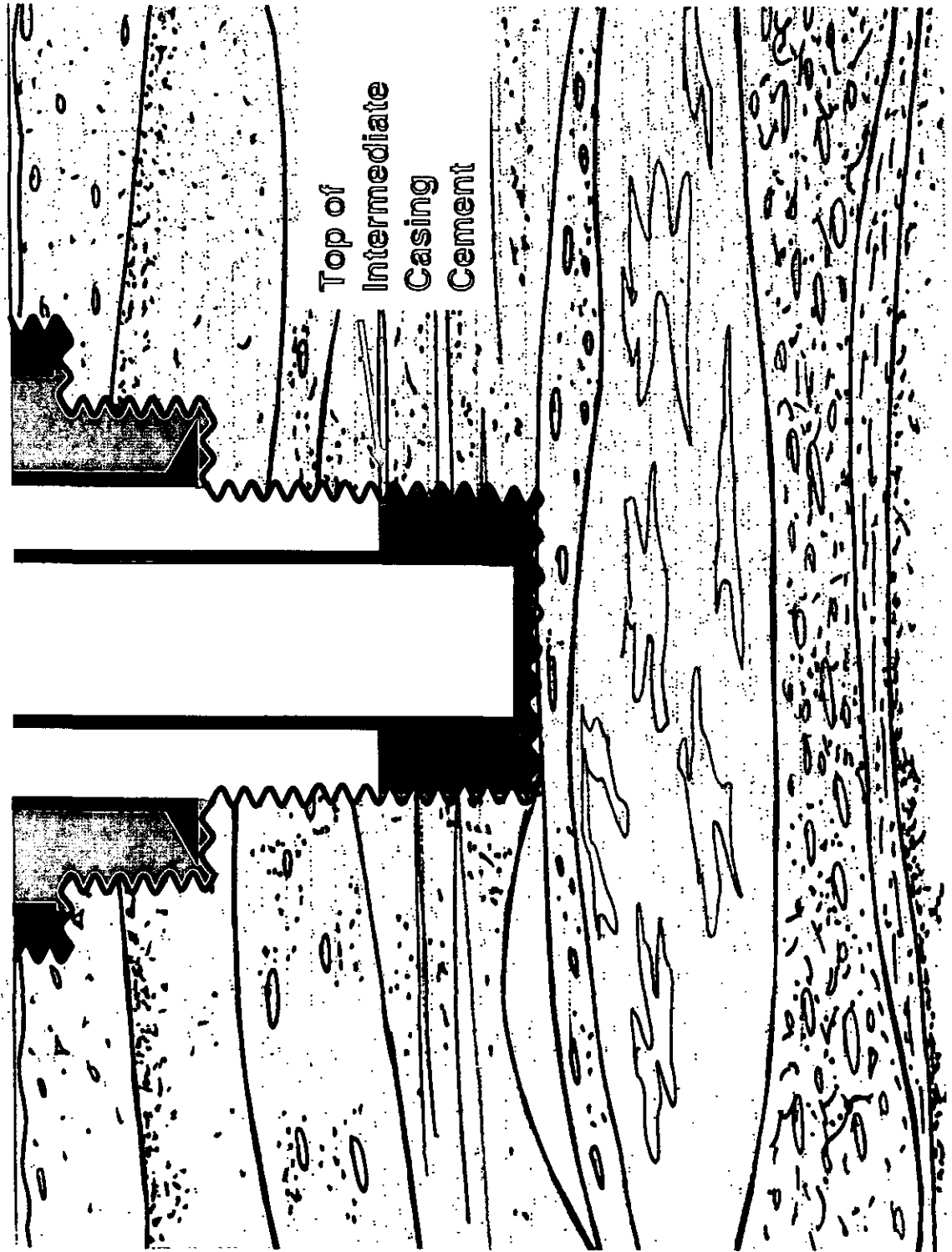
WELL CONSTRUCTION

INTERMEDIATE CASING RUN



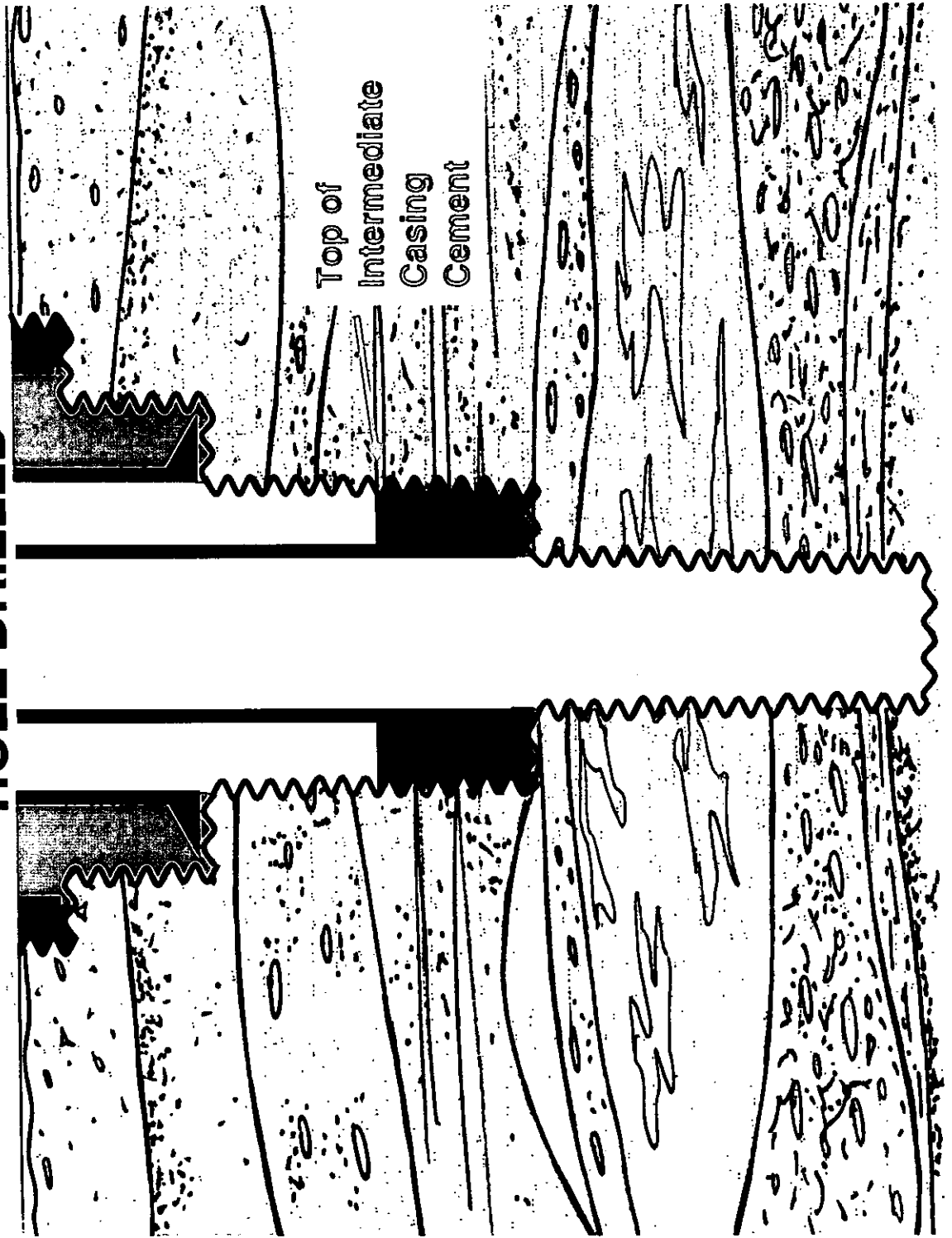
WELL CONSTRUCTION

INTERMEDIATE CASING CEMENTED



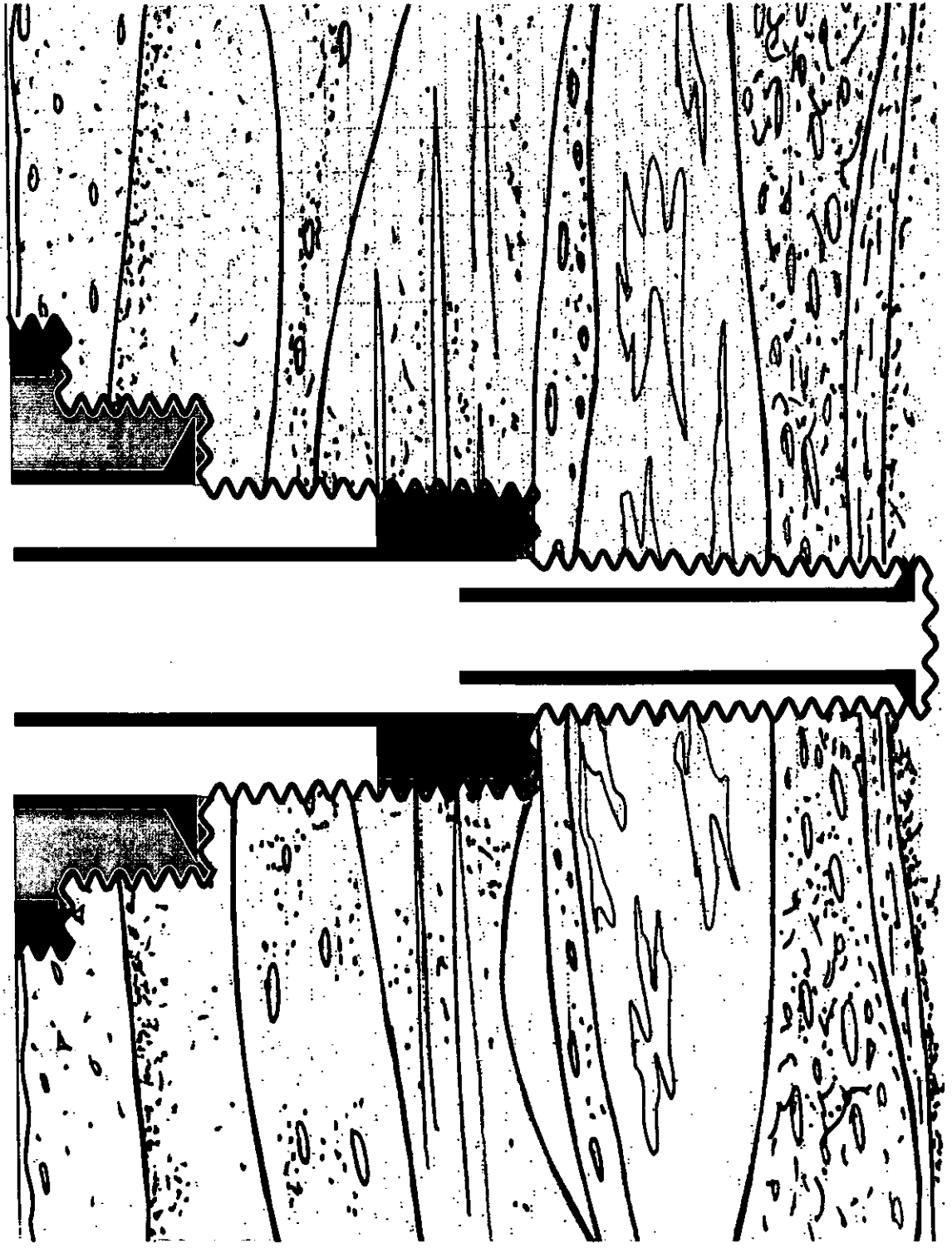
WELL CONSTRUCTION

REMAINDER OF PRODUCTION HOLE DRILLED



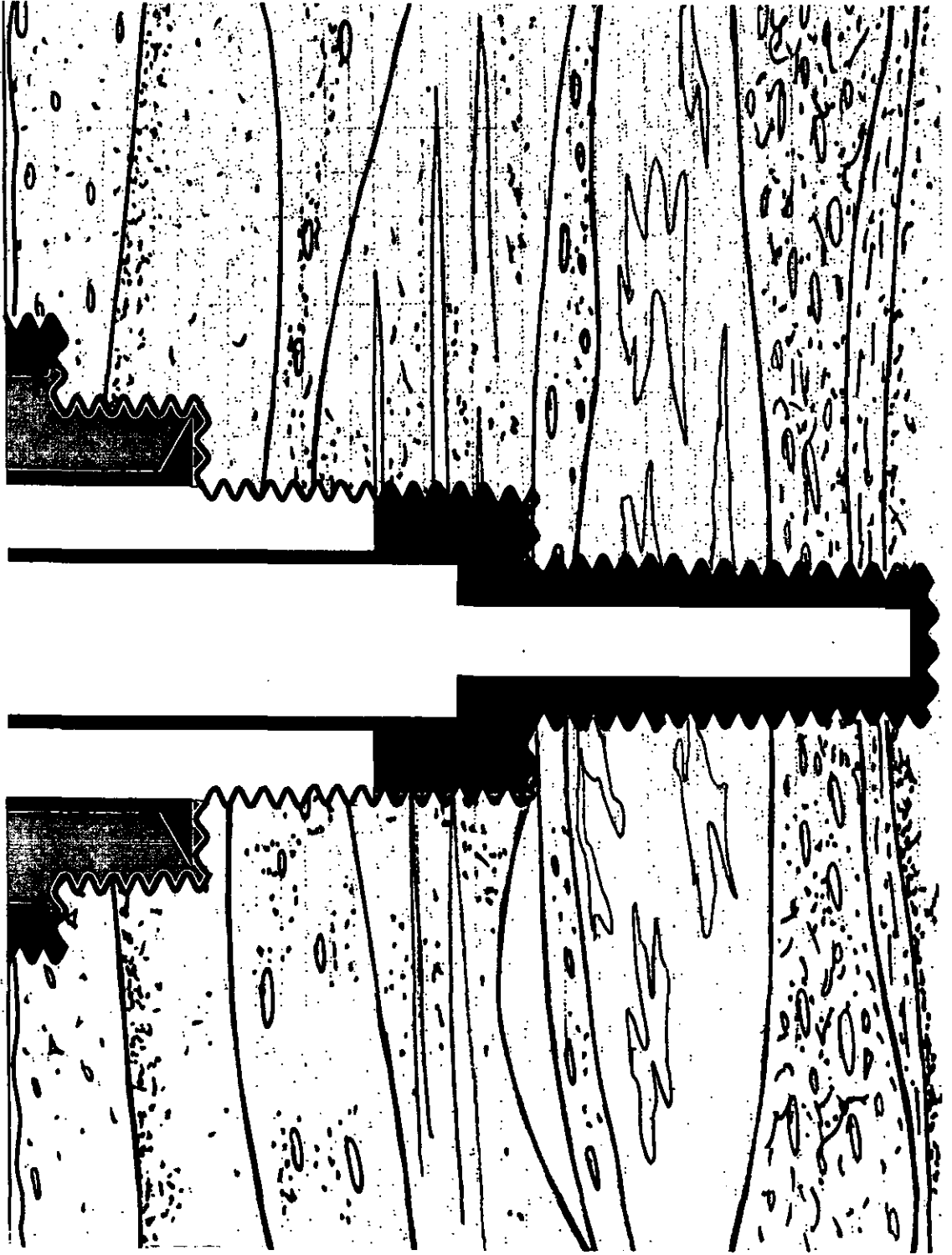
WELL CONSTRUCTION

RUN PRODUCTION LINER



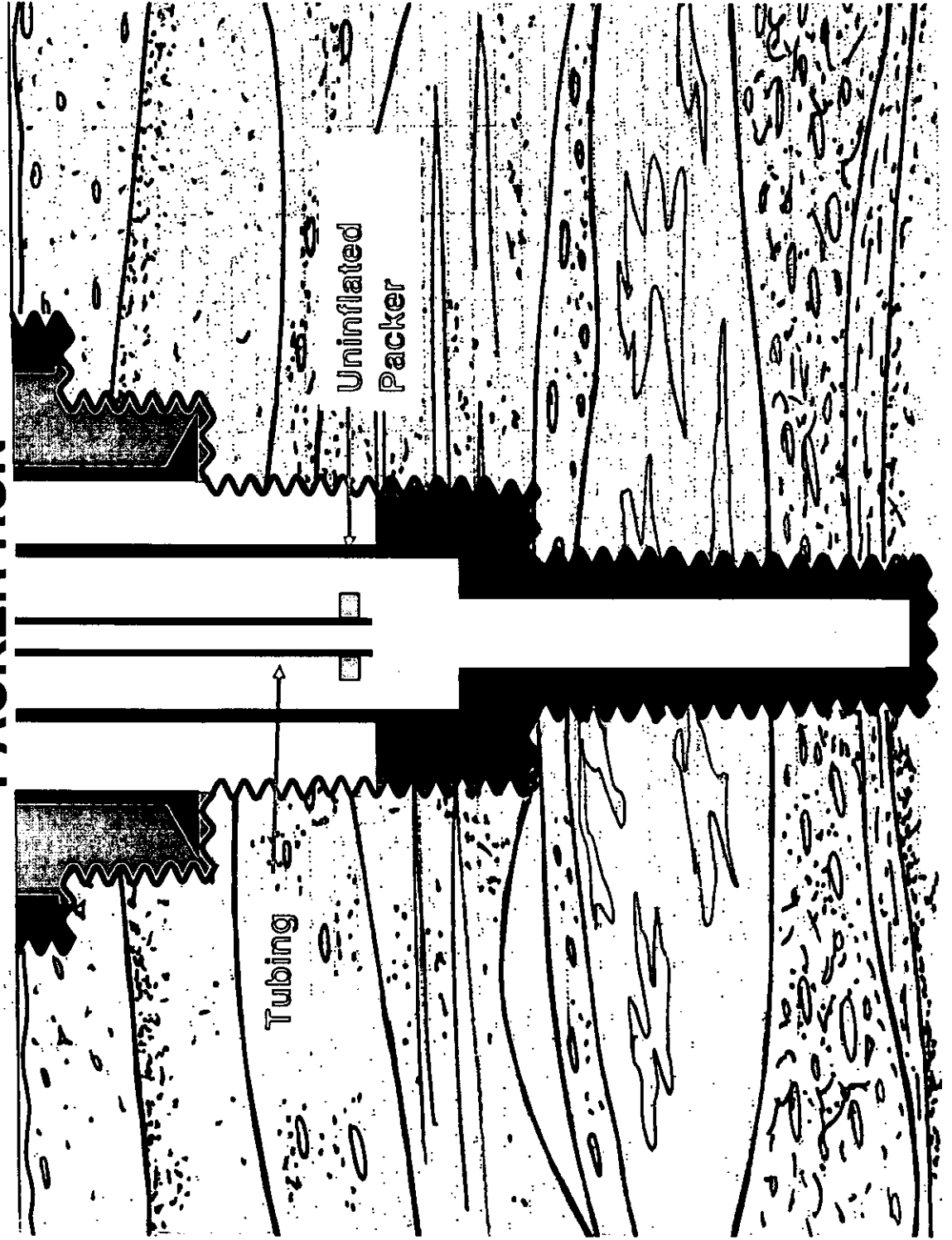
WELL CONSTRUCTION

PRODUCTION LINER CEMENTED



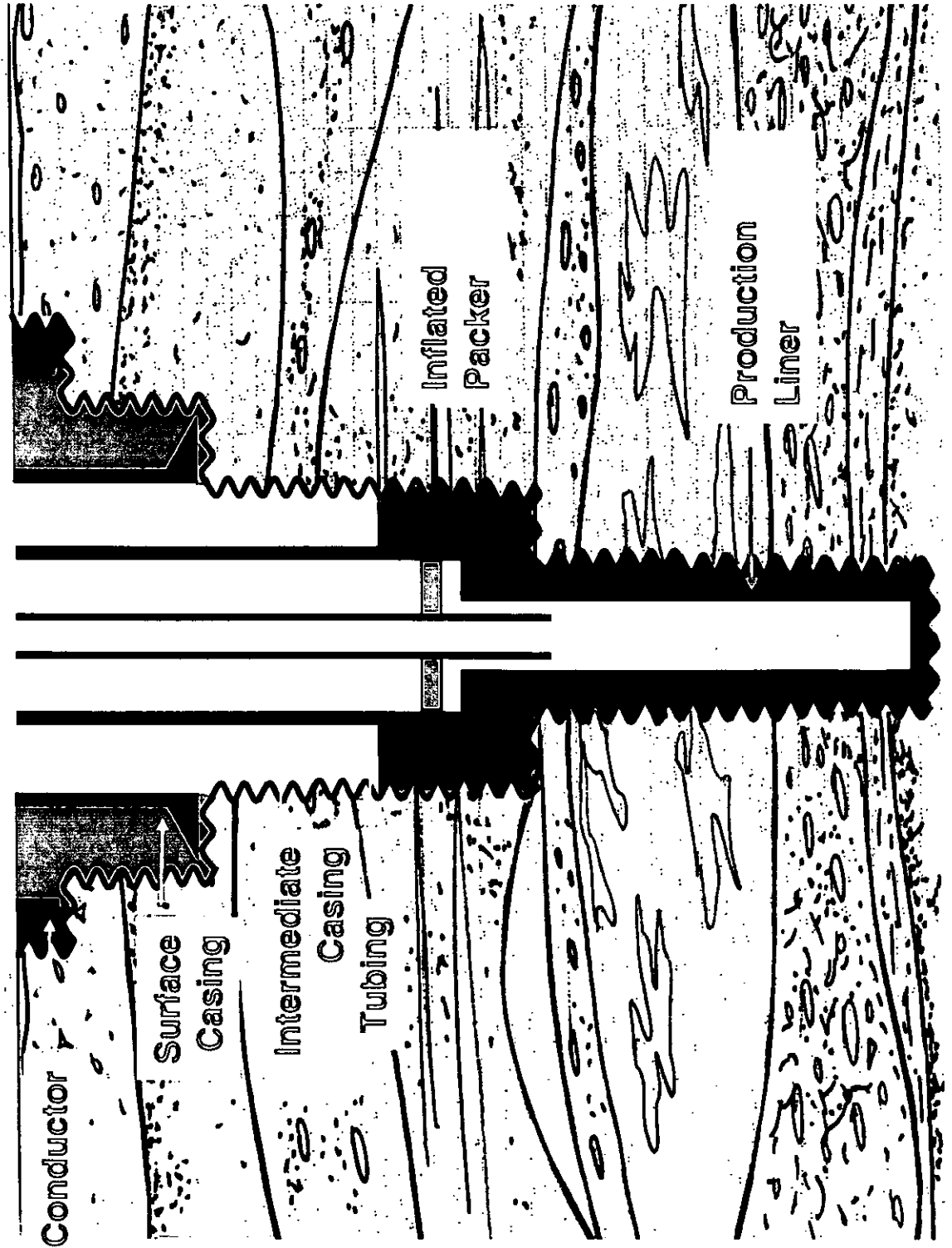
WELL CONSTRUCTION

PRODUCTION TUBING & PACKER RUN



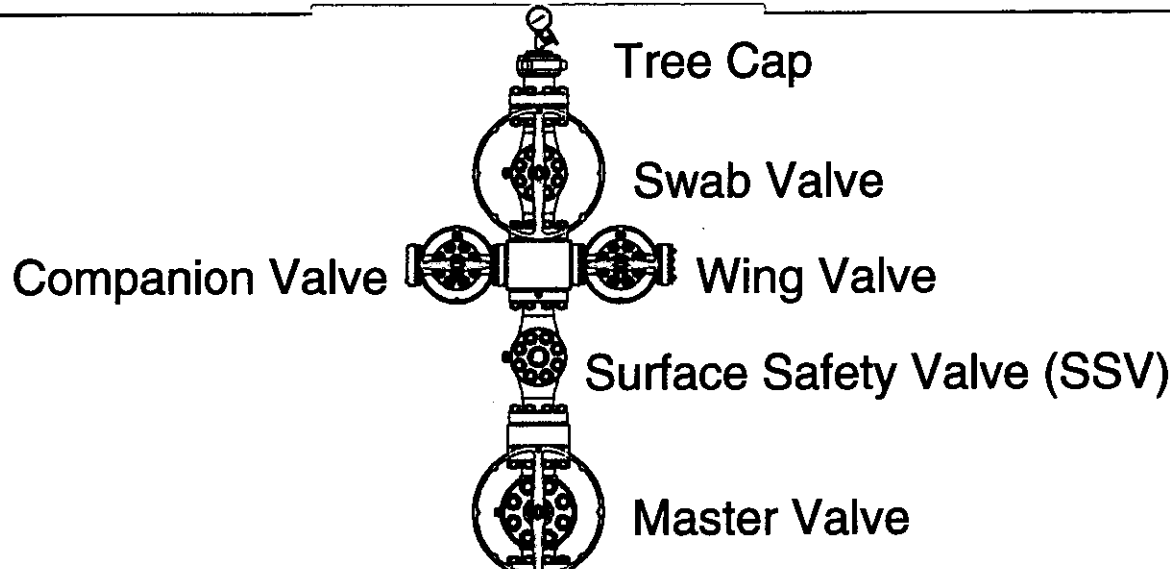
WELL CONSTRUCTION

PACKER SET

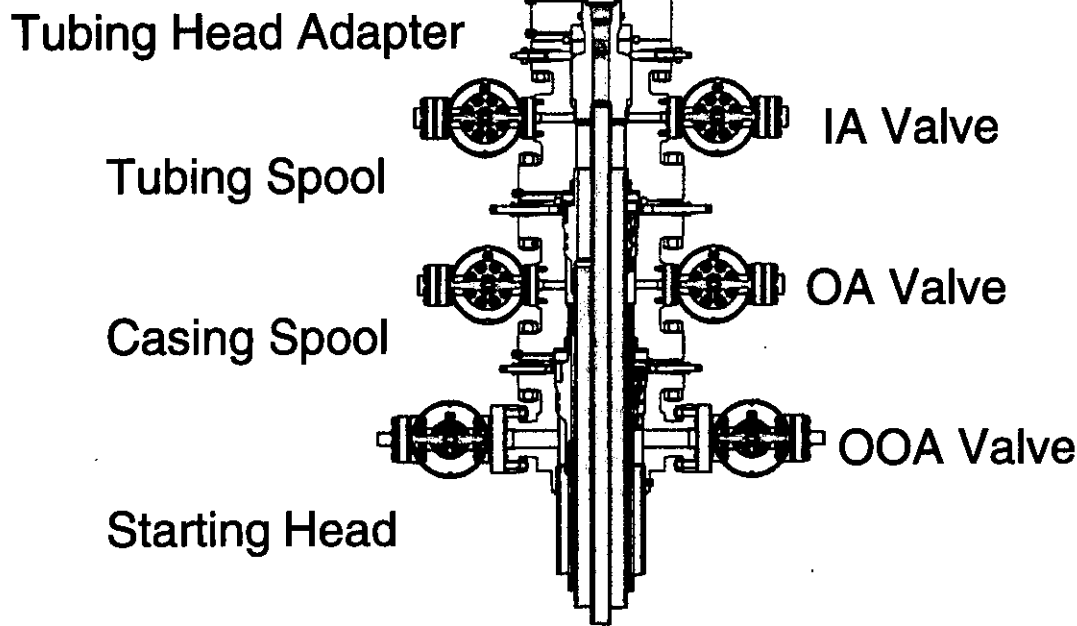


WELL CONSTRUCTION

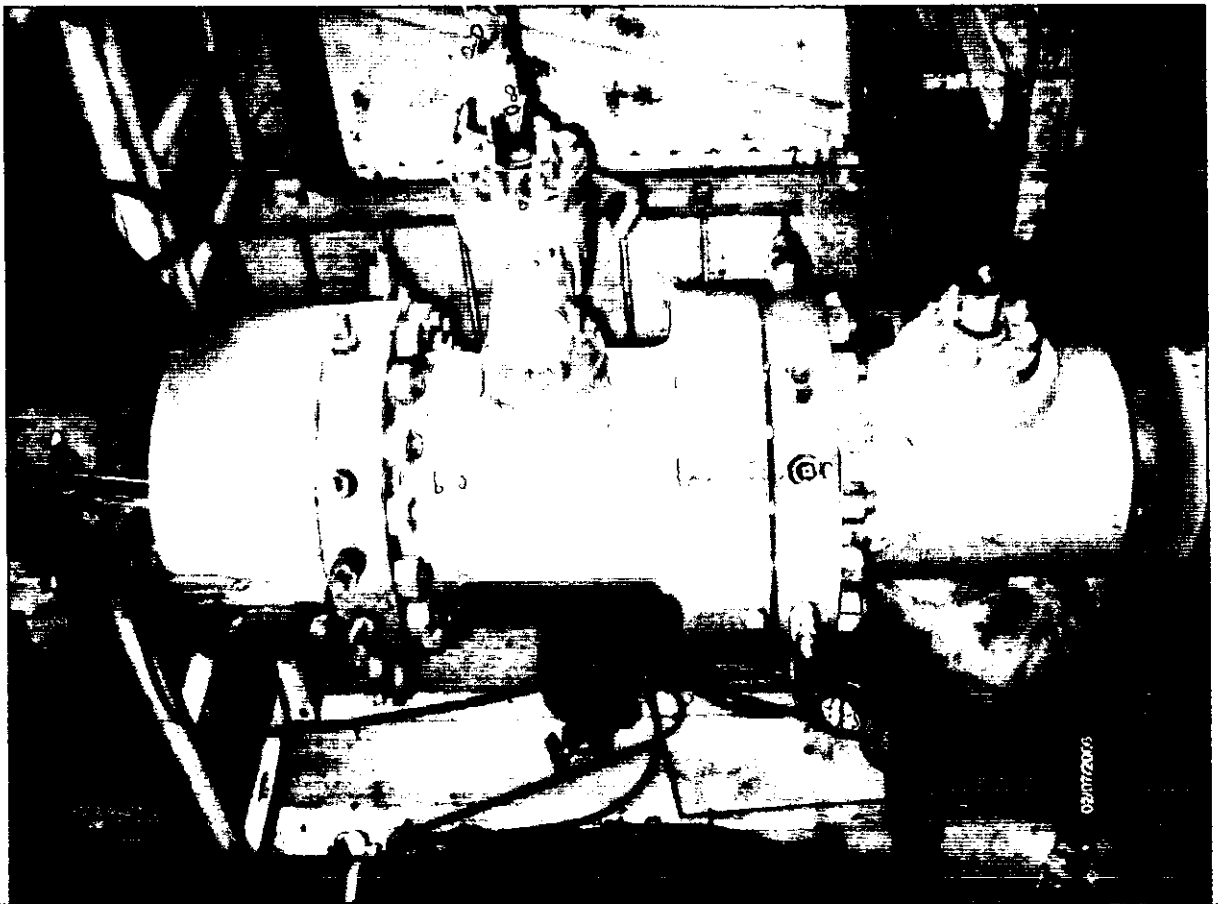
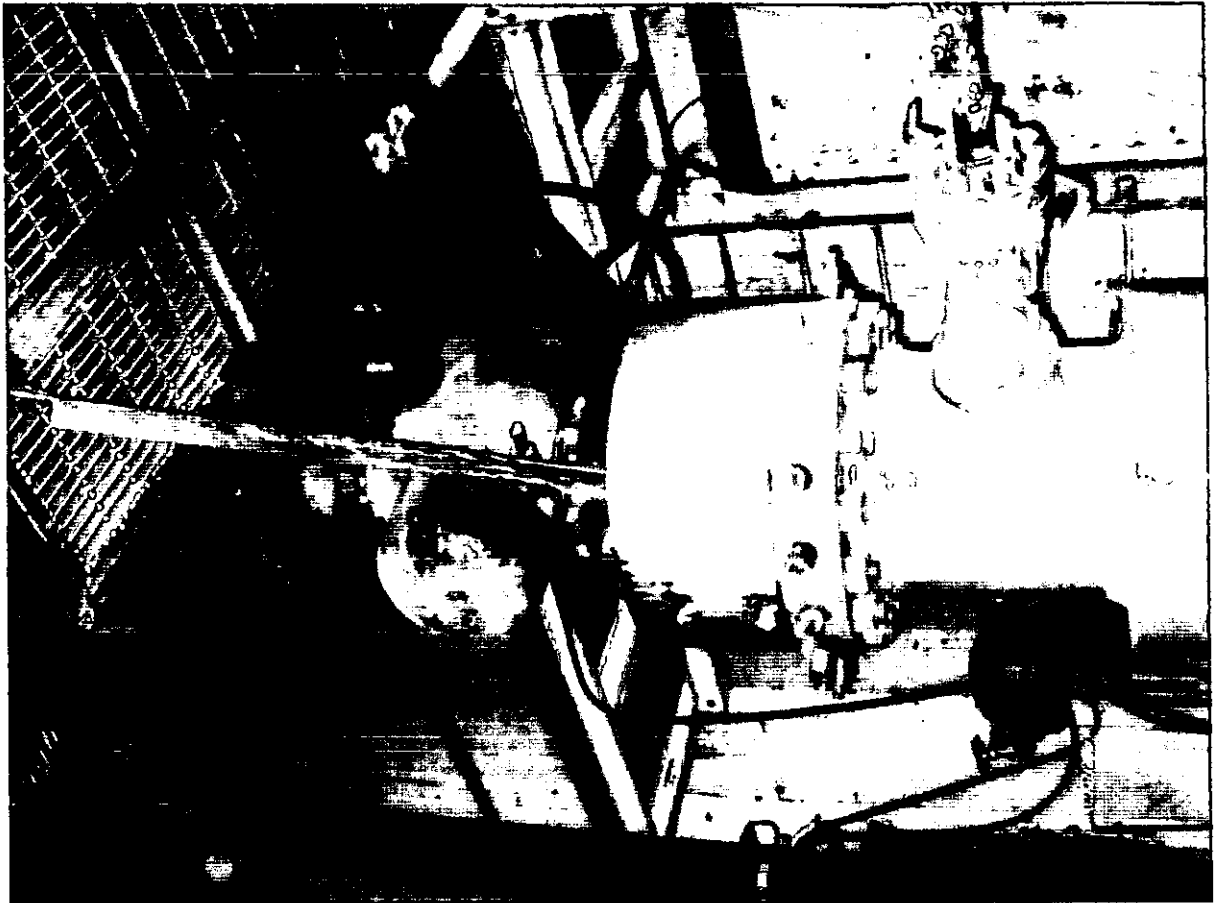
Christmas Tree



Wellhead

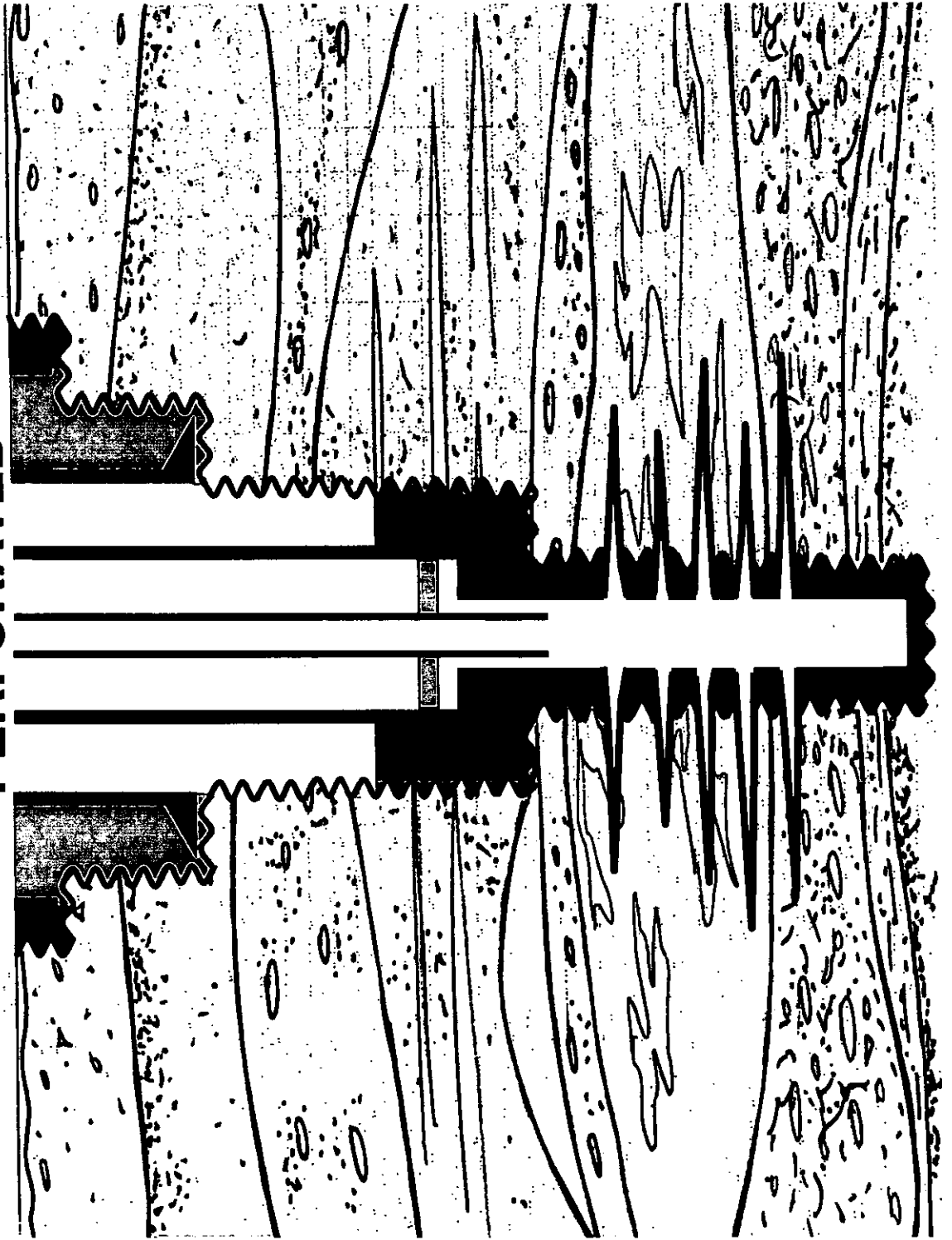


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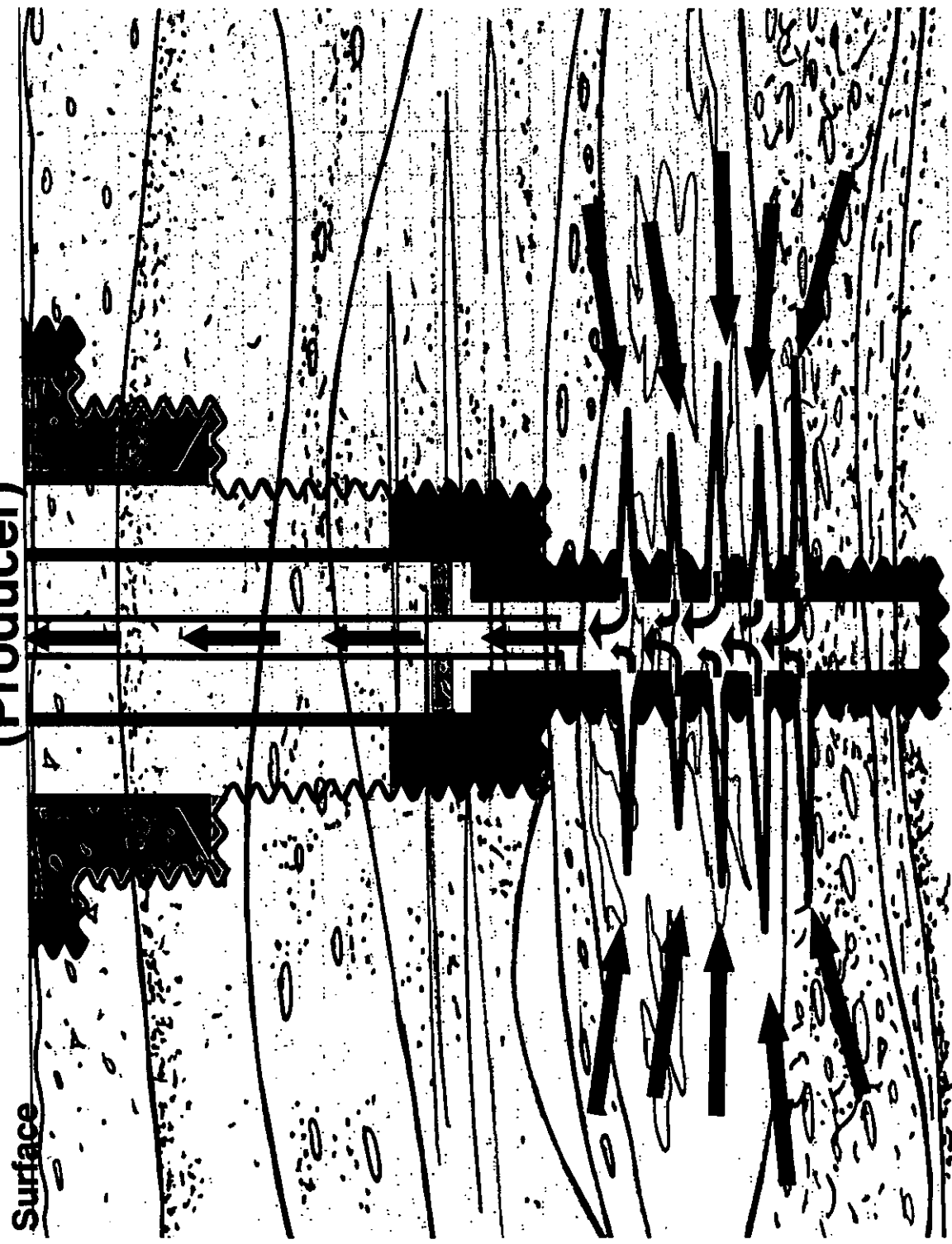


WELL CONSTRUCTION

RESERVOIR INTERVAL PERFORATED

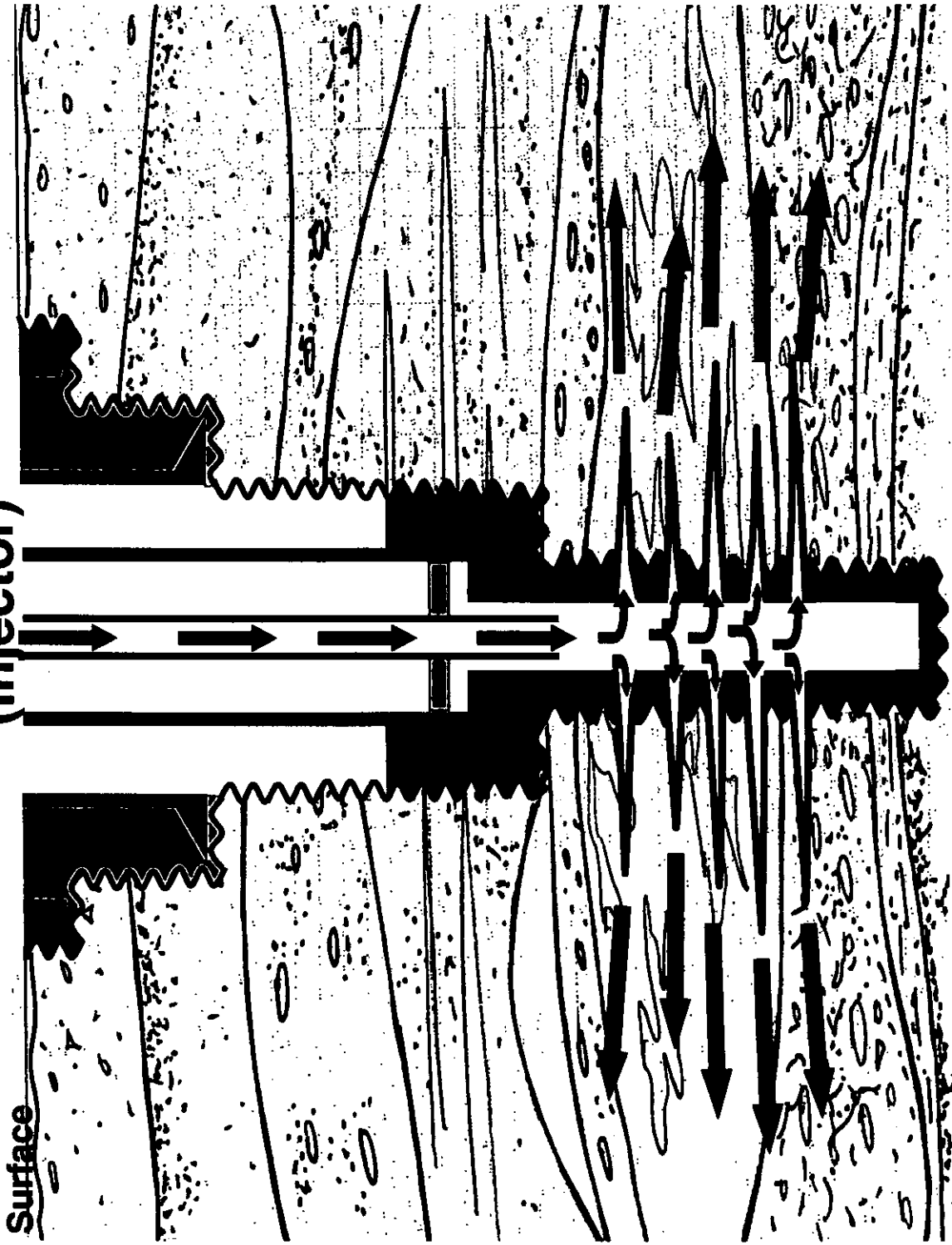


FLOWING WELL (Producer)



WELL ON INJECTION

(Injector)



Nordic 1 Over K-16A

Coiled Tubing Drilling Unit



The Basic Sidetrack

Parent - 4 1/2" production tubing
- 7" liner

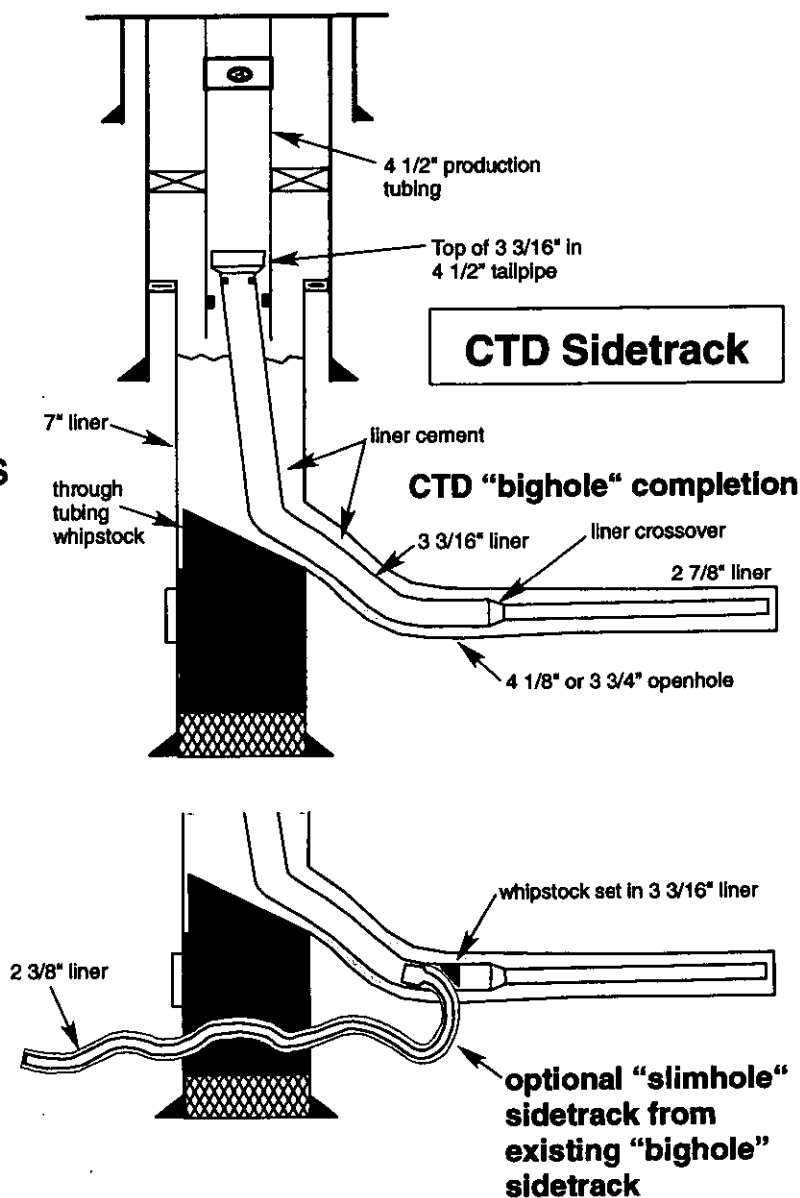
Pre rig

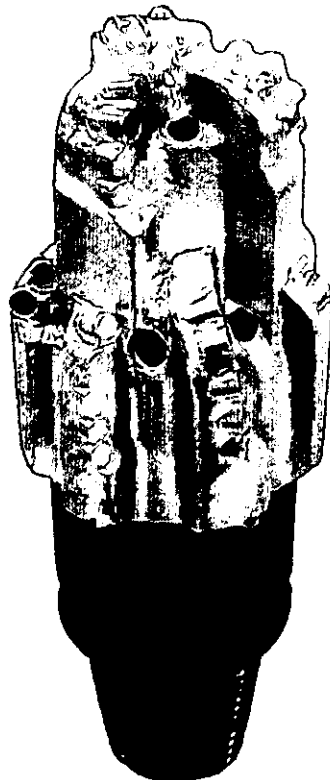
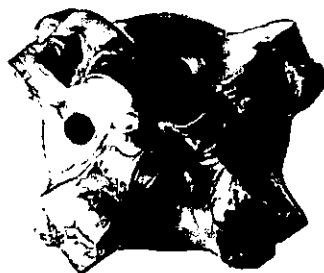
- Set whipstock
- Squeeze cement to abandon perfs

CTD

- Mill window
- Drill - 3 3/4" or 4 1/8" bicenter
 - 45° DLS common
 - Xanthan drilling fluid
- Run 3 3/16" x 2 7/8" liner & cmt
- Log CNL & Perforate

2 3/4" slimhole option →
increases candidates





build section
3 3/4" x 4 1/4"
bicenter



lateral section
3 3/4"



conglomerate
3 3/4"



Lisburne carbonate



openhole sidetrack

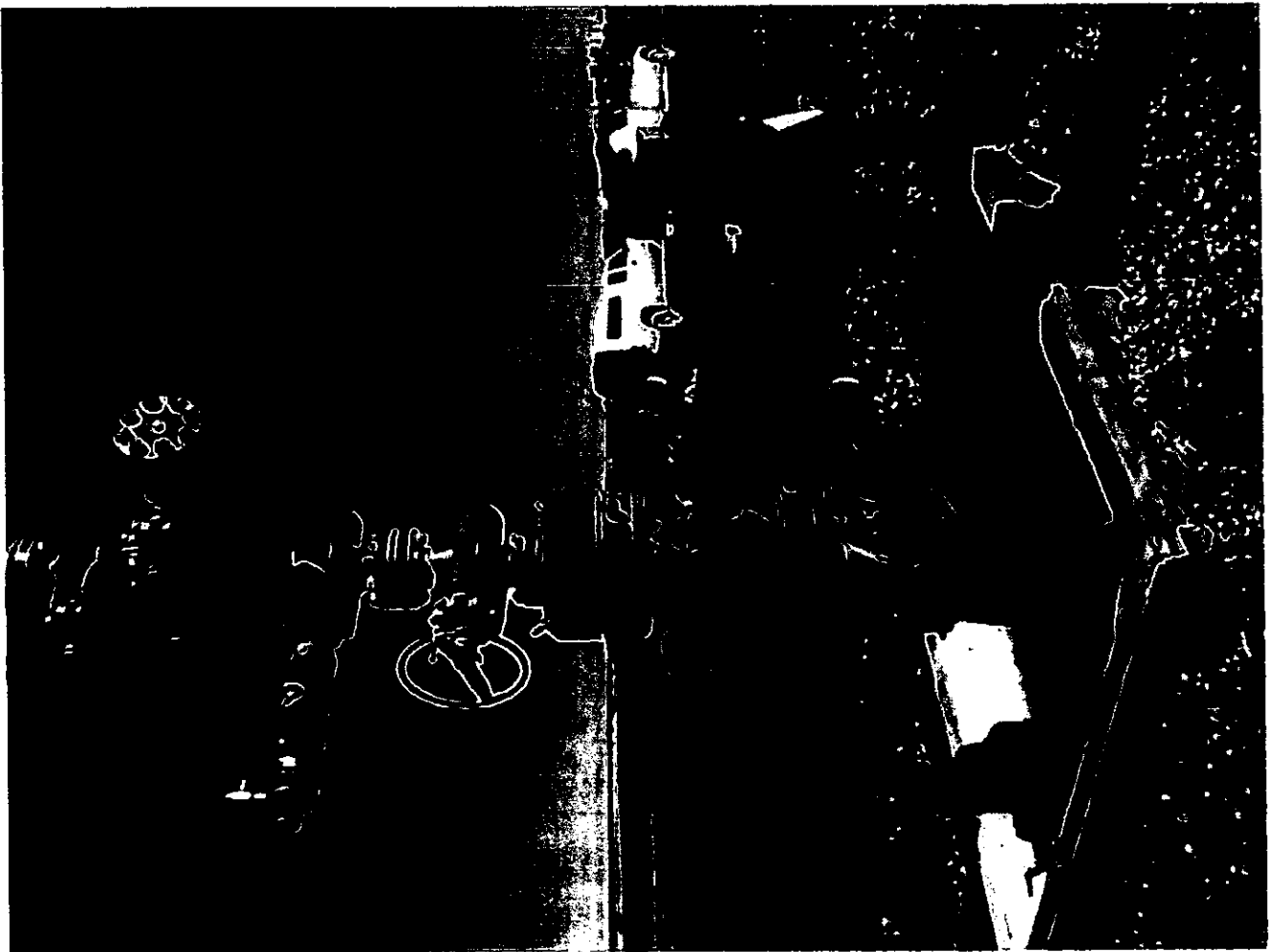


hard streak carbonate



size

Questions...





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