PETROLEUM 101

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PRESENTATION STRUCTURE

- The Offshore Petroleum Industry
- Petroleum Geology
- Petroleum Technology:
  - Exploration agreements
  - Geophysical exploration
  - Drilling
  - Development
  - Production
- Discussion

WHY IS THIS STUFF IMPORTANT?

- Important to Understand the Petroleum Industry:
  - Language and terminology (MODU, EOI, FPSO, OGP, E&P, HSE, TD, DNV, OTC, BOP…)
  - Culture
  - Activities and priorities
  - Requirements
- Important to Recognize Causes and Significance of Uncertainty

THE OFFSHORE PETROLEUM INDUSTRY

- Truly Global
- Technologically Intensive and Innovative
- Business Culture: Strong, Conservative and Male
- High Mobility of Executives and Specialists (cf Military)
- Oil and Gas Companies (Operators):
  - Majors, independents and national
  - Philosophies and cultures vary
  - Increased downsizing and outsourcing

THE OFFSHORE PETROLEUM INDUSTRY

- Operators Increasingly Focus on:
  - Asset management
  - Finance
  - Marketing
- Construction, Fabrication, Supply and Service Companies (Contractors):
  - Increasingly important
  - International, national and local
  - Companies vary greatly by activity phase
- Industry Skill and Experience Needs Vary:
  - Highly specialized and mobile
  - Existing local capabilities

THE OFFSHORE PETROLEUM INDUSTRY

- Large Sums of Money:
  - Expenditures (exploration; development)
  - Income (Hibernia; Terra Nova)
- Dangerous Work Environments
- Industry Very Demanding re:
  - Risk
  - Timing (24/7)
  - Quality management
  - Health, Safety and Environment (HSE)
  - Monitoring and Auditing
- Part of the Culture of the Industry

PETROLEUM GEOLOGY: OVERVIEW

- Rock Types
- Origins of Petroleum
- Rock Characteristics
- Traps
- Pools and their Contents
- Accumulations

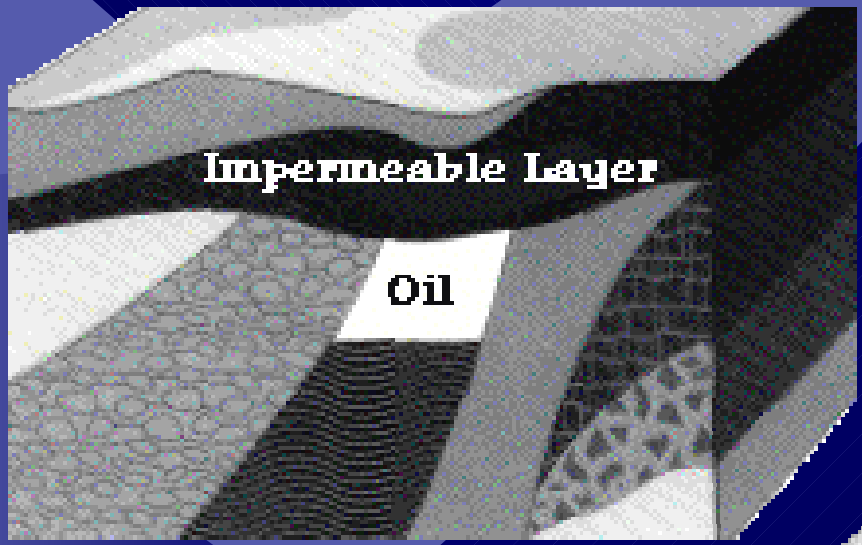
PETROLEUM GEOLOGY

- Rock Types:
  - Igneous
  - Metamorphic
  - Sedimentary
- Origins of Petroleum:
  - Generation
  - Maturation
  - Migration

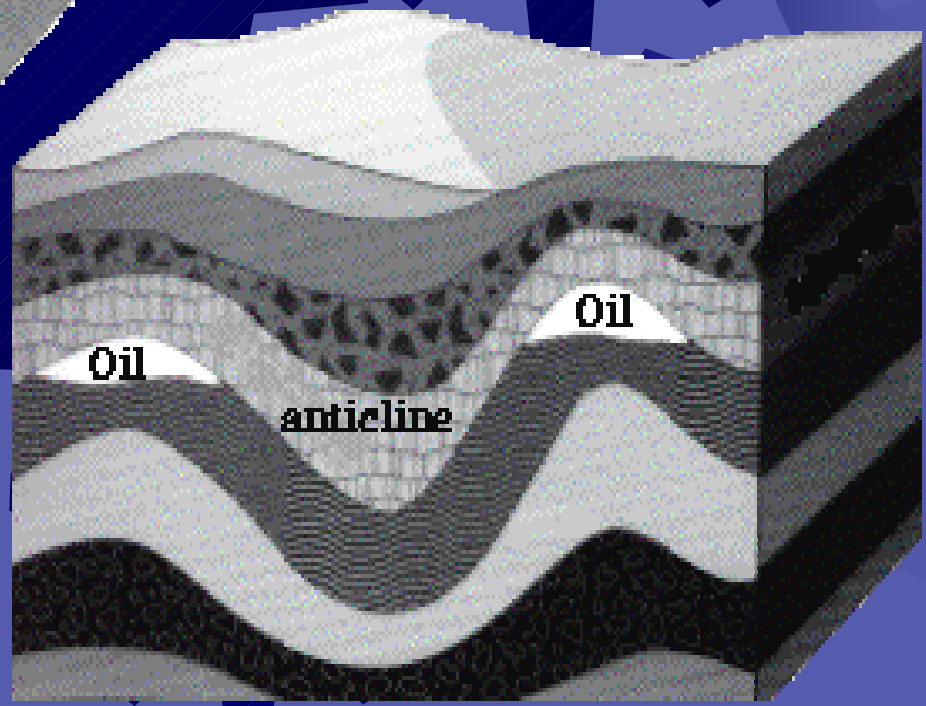
PETROLEUM GEOLOGY

- Rock Characteristics:
  - Porosity
  - Permeability
- Traps Require:
  - Reservoir
  - Seal
  - Concave from below
- Types:
  - Stratigraphic
  - Anticlinal

Stratigraphic Trap

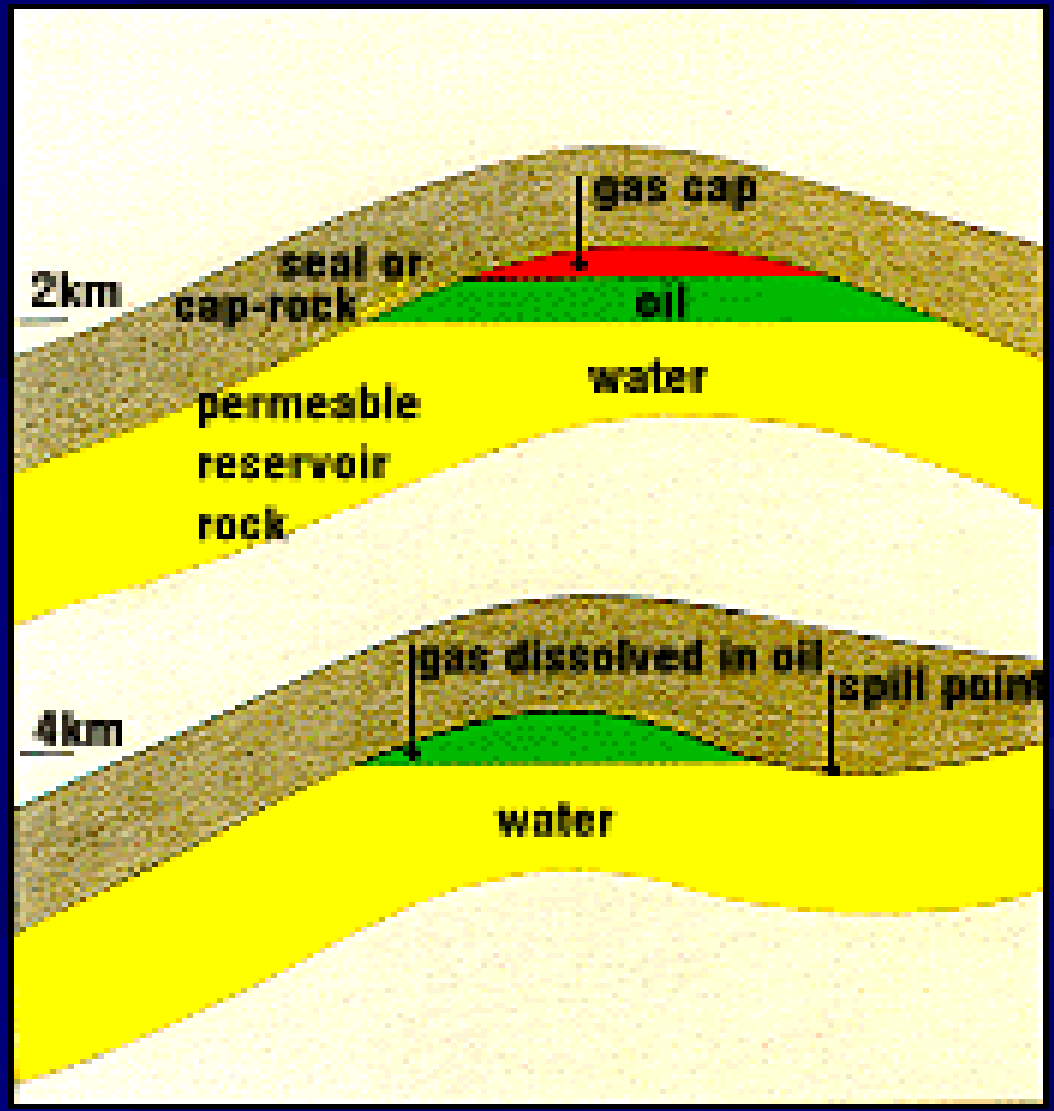


Anticlinal Trap



PETROLEUM GEOLOGY

- Pool Contents:
  - Gas/oil contact
  - Oil/water contact
  - Spill point
- Accumulations:
  - Pool
  - Field
  - Basin


gas cap
seal or
cap-rock
2km
oil
water
permeable
reservoir
rock
gas dissolved in oil
spill point
4km
water

PETROLEUM TECHNOLOGY: OVERVIEW

- Exploration Agreements
- Geophysical Exploration
- Drilling
- Development/construction
- Production/operations

PHASES OF ACTIVITY

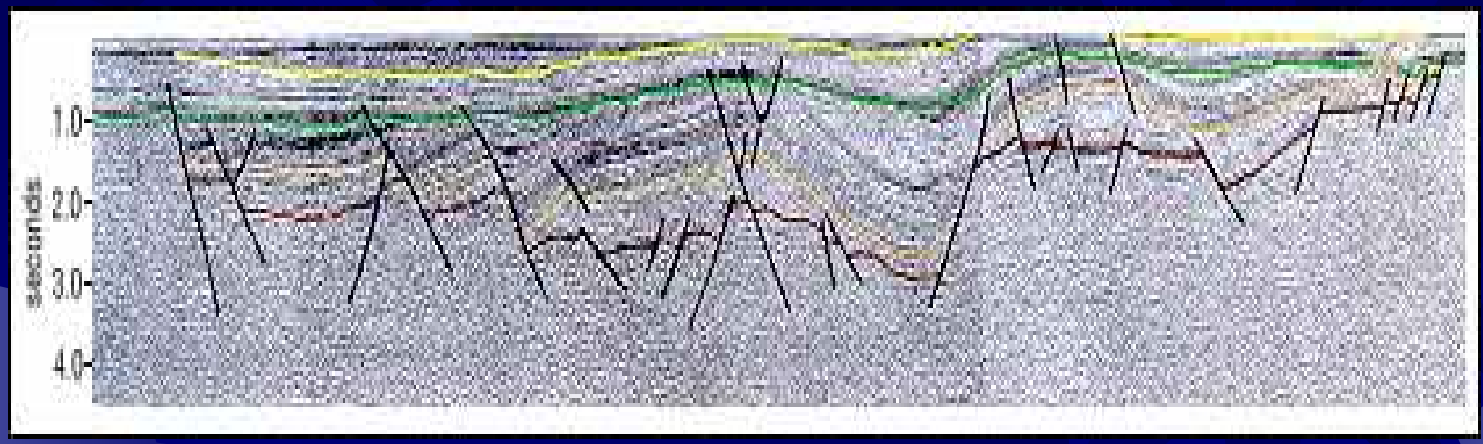
- Exploration
- Pre-development
- Development (Construction)
- Production (Operations)
- Decommissioning (Wind-down)

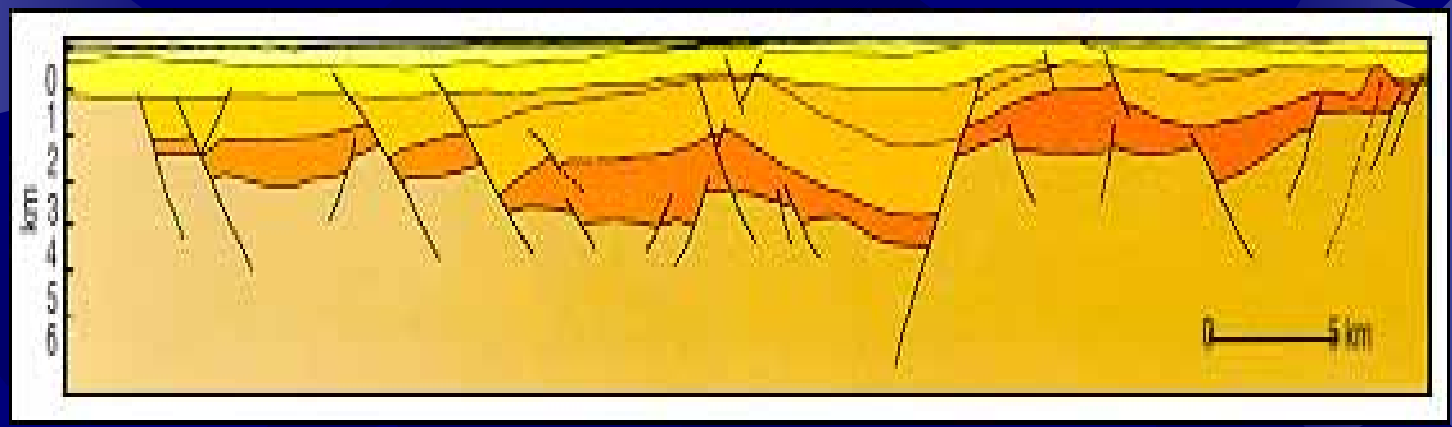
PETROLEUM TECHNOLOGY

- Exploration Agreements:
  - Cash
  - Seismic or drilling activity
  - Local benefits
  - Environmental protection
  - Land return
- Pooling Risk:
  - Farm-ins
  - Farm-outs

PETROLEUM TECHNOLOGY

- Geophysical Exploration:
  - Magnetic
  - Gravity
  - Seismic (2D, 3D) *(4D)*
- Drilling:
  - Wildcat (rank, new field)
  - Stratigraphic test
  - Confirmation (appraisal, step-out)
  - Development (production)


1.0
2.0
3.0
4.0
seconds


0
1
2
3
4
5
6
km
0
5 km

PETROLEUM TECHNOLOGY

- Choice of Drillsite:
  - Well prognosis
  - Exploration philosophy
- Drilling Equipment:
  - Drilling rig
  - Drill bit
  - Derrick
  - Drill pipe
  - Drill string

PETROLEUM TECHNOLOGY

- Drilling Equipment (continued):
  - Trip
  - Kelly
  - Rotary table
  - Rig motors
  - Drilling mud (cools, clears, controls pressure)
  - Cuttings
  - Shale shaker
  - Mud tank

PETROLEUM TECHNOLOGY

- Well Control:
  - Over-pressured reservoirs
  - Blowout vs control
  - Mud (barite)
  - Lost circulation
  - Blowout preventer (BOP)
- Drilling Techniques:
  - Spudding
  - Surface hole
  - Casing

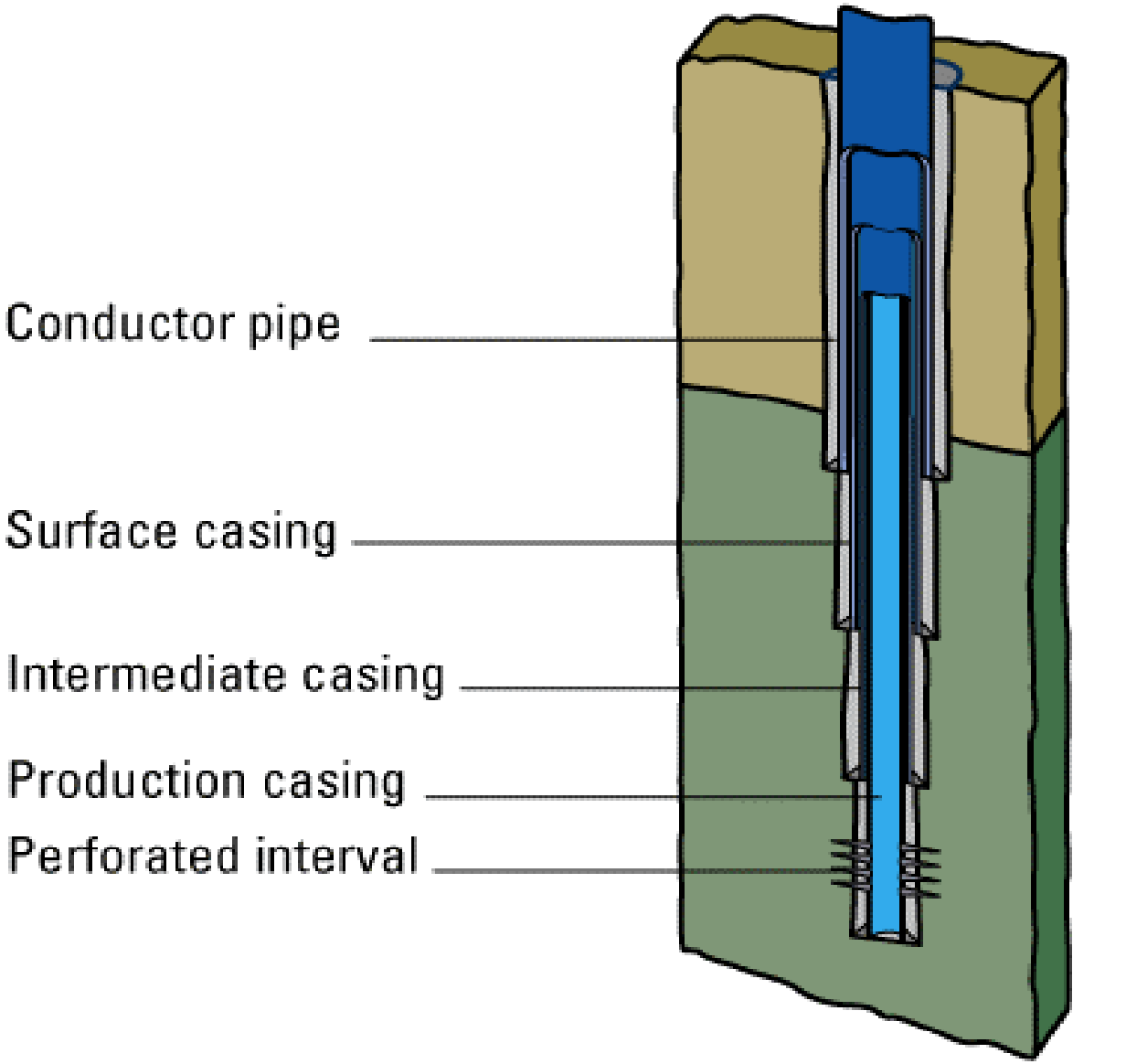
PETROLEUM TECHNOLOGY

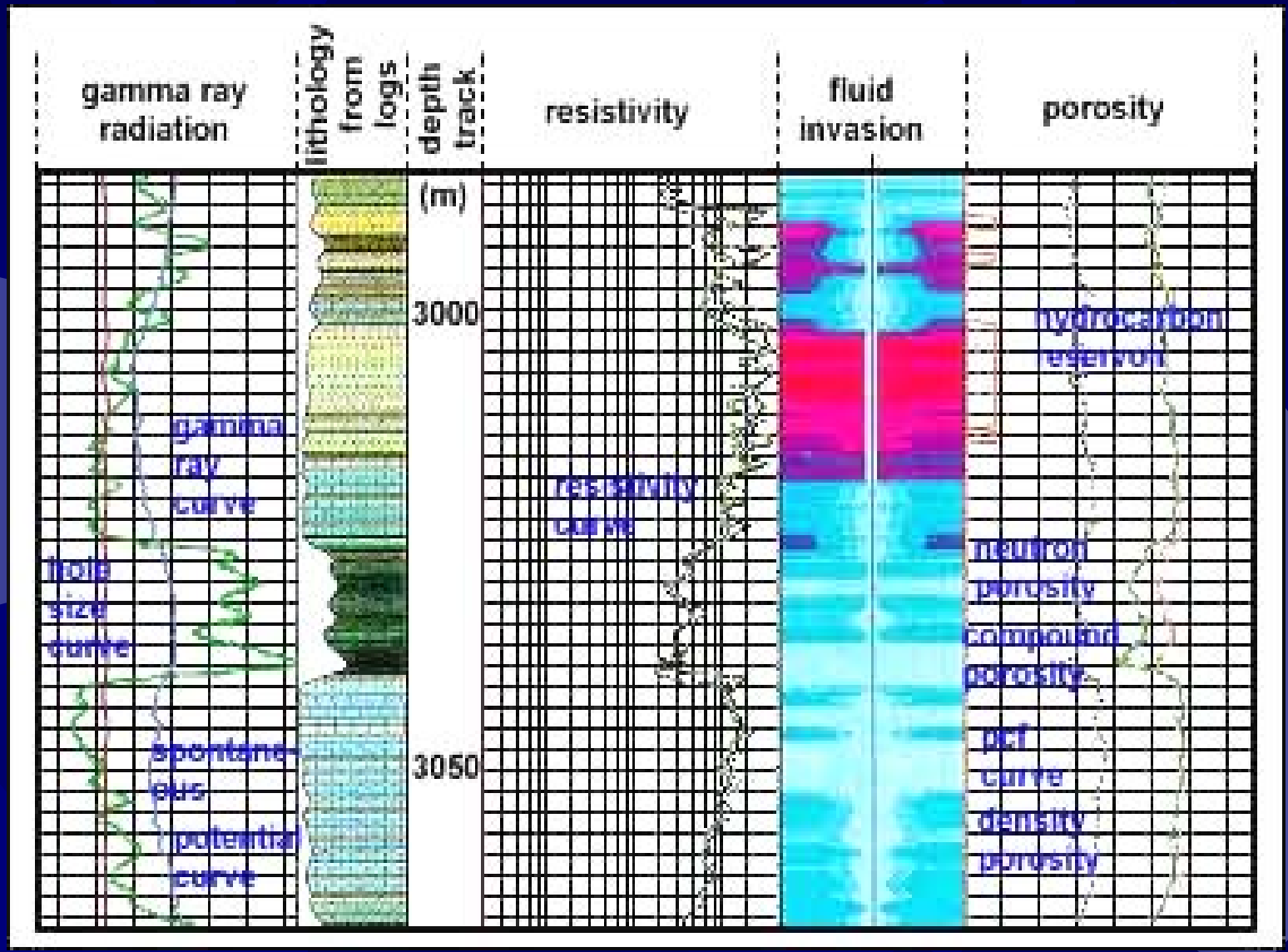
- Drilling Techniques (cont.):
  - Total depth (TD)
  - Fishing
  - Sidetracking
  - Deviated wells/directional drilling

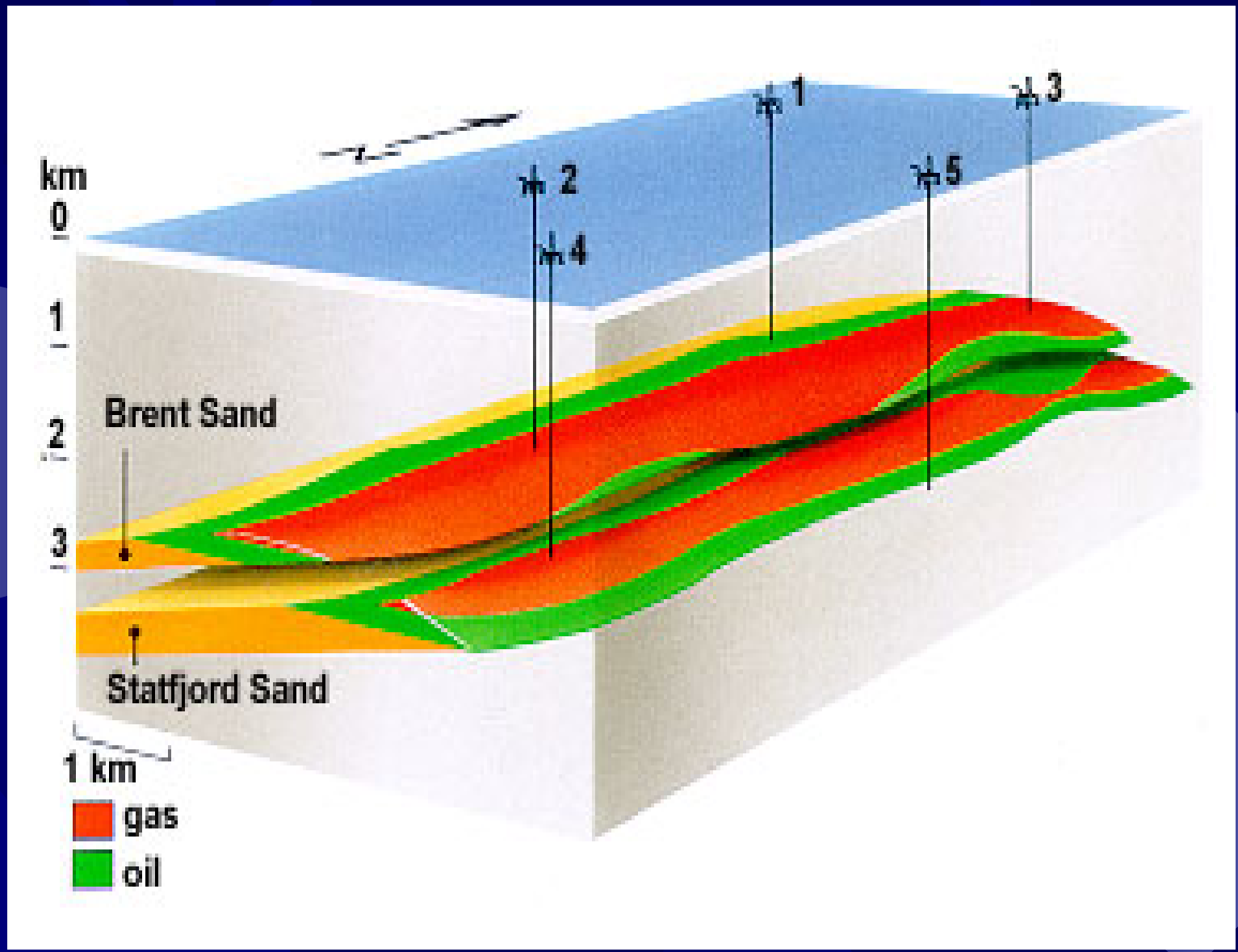
PETROLEUM TECHNOLOGY

- Samples, Logs and Tests:
  - Samples and cores
  - Logging
  - Sonde (electrical, radiation, temperature, sonic velocity)
  - Testing (drill stem test)
  - Perforation
- Completion:
  - Bridge plugs
  - Production tubing
  - Well head (christmas tree)


VARCO

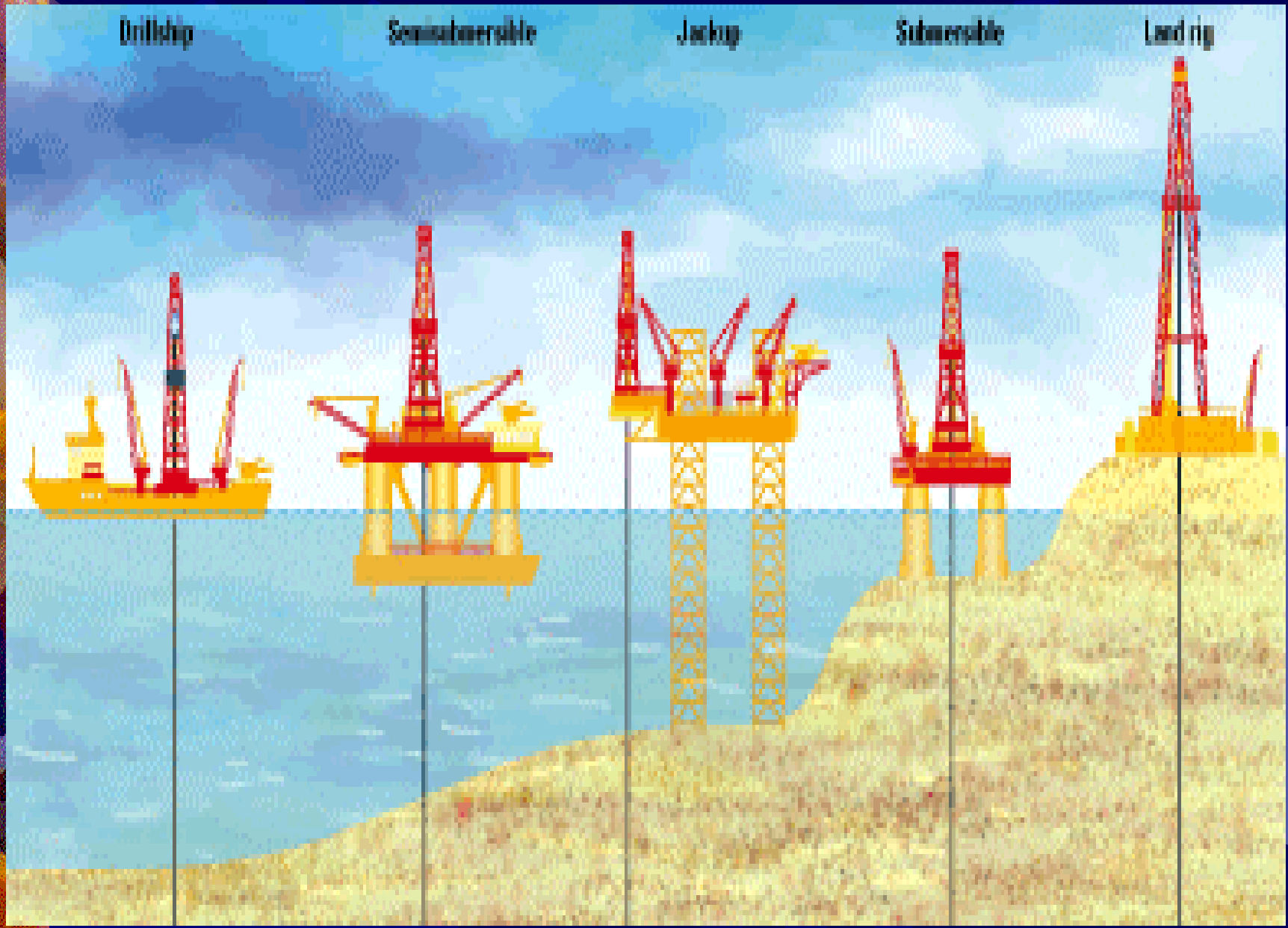

Conductor pipe
Surface casing
Intermediate casing
Production casing
Perforated interval

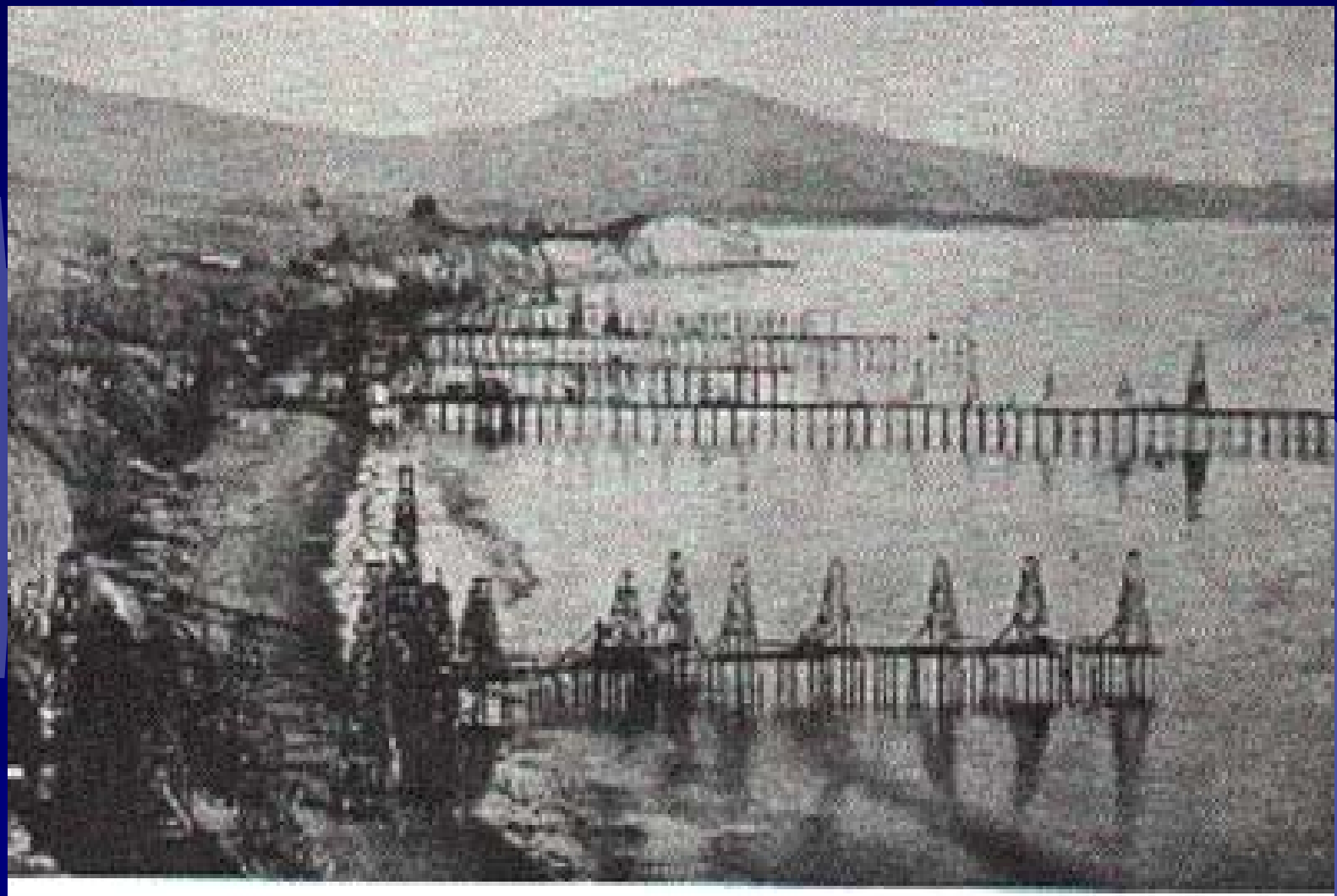

gamma ray radiation
lithology from logs
depth track
resistivity
fluid invasion
porosity
(m)
3000
3050
gamma ray curve
hole size curve
spontaneous potential curve
resistivity curve
hydrocarbon reservoir
neutron porosity
compound porosity
pcf curve
density porosity


km
0
1
2
3
1
2
3
4
5
Brent Sand
Statfjord Sand
1 km
gas
oil

PETROLEUM TECHNOLOGY

- Offshore Drilling:
  - Platform (pier)
  - Artificial island
  - Submersible
  - Jack-up
  - Semi-submersible (anchored; DP)
  - Drillship
  - ‘MODU’


Drillship
Semisubmersible
Jackup
Submersible
Land rig



Summerland in 1899


EIRIK RAUDE
NASSAU

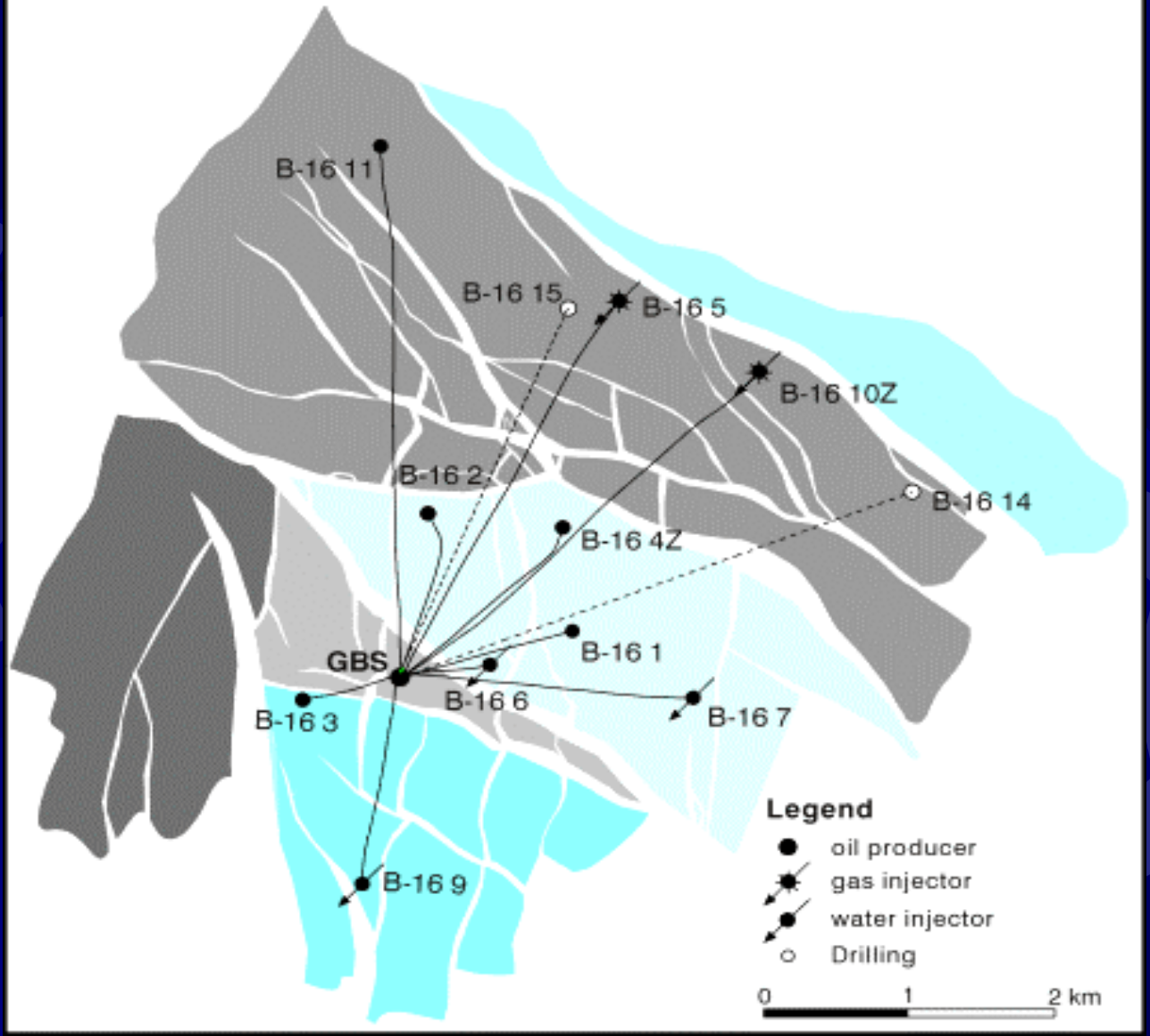
PETROLEUM TECHNOLOGY

- Drilling and Production Support:
  - Supply base and vessels
  - Heliport and helicopters
  - Crewboats
  - Onshore supplies
  - Onshore services

PETROLEUM TECHNOLOGY

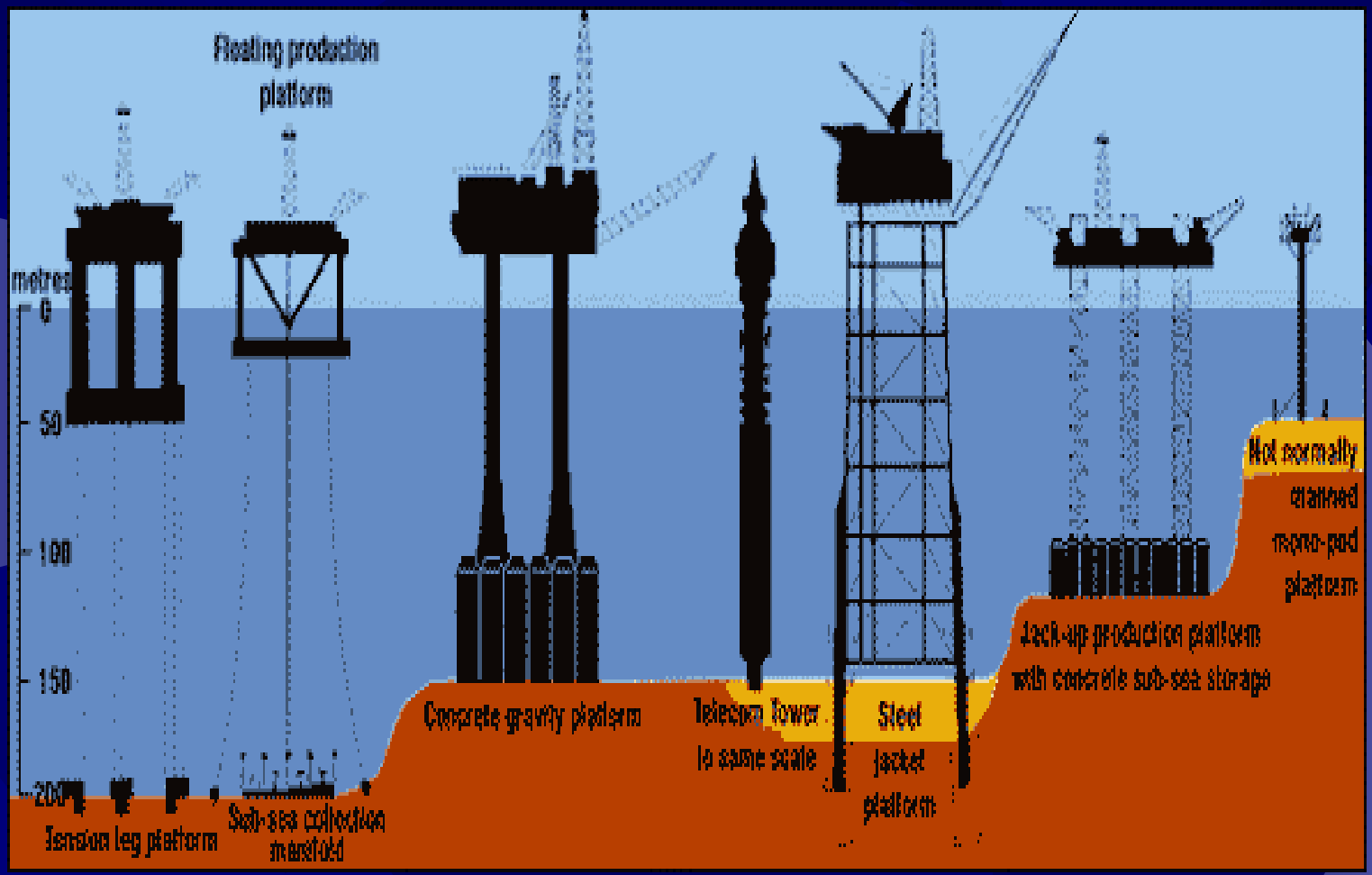
- Development Technology
- Reservoir:
  - Permeability (acidization, hydro-fracturing)
  - Pressure (injection, re-injection)
  - Treatment (separation, washing and H2S)

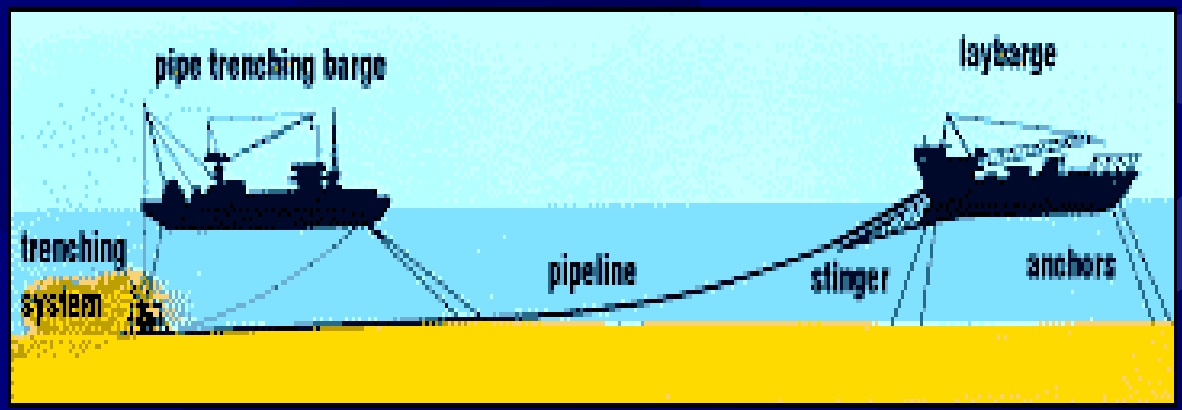
Figure 4
Hibernia Reservoir: Well Locations



PETROLEUM TECHNOLOGY

- Production System Drilling:
  - Fixed (concrete, steel, spar, tension leg)
  - Floating (FPSO, FPO)
  - Sub-sea
  - From land
- Transportation:
  - Pipeline
  - Tanker


Floating production platform
metres
0
50
100
150
200
Tension leg platform
Sub-sea collection manifold
Concrete gravity platform
Telecom tower
to same scale
Steel jacket platform
Jack-up production platform with concrete sub-sea storage
Not normally manned mono-pod platform


pipe trenching barge
layberge
trenching
system
pipeline
stinger
anchors