Introduksjon til Petroleum Engineering

TMR4325

Presenter: Prof. Milan Stanko

Førelopig agenda

- 10:15 - Introduksjon til petroleumsteknologi

- 10:40 - Litt om historie av oljeindustrien og reservoarteknikk

- 11:10 - Gruppearbeid Nr.1

- 11:45 - Gruppearbeid Nr.2

- 12:45 – Gruppearbeid Nr. 3
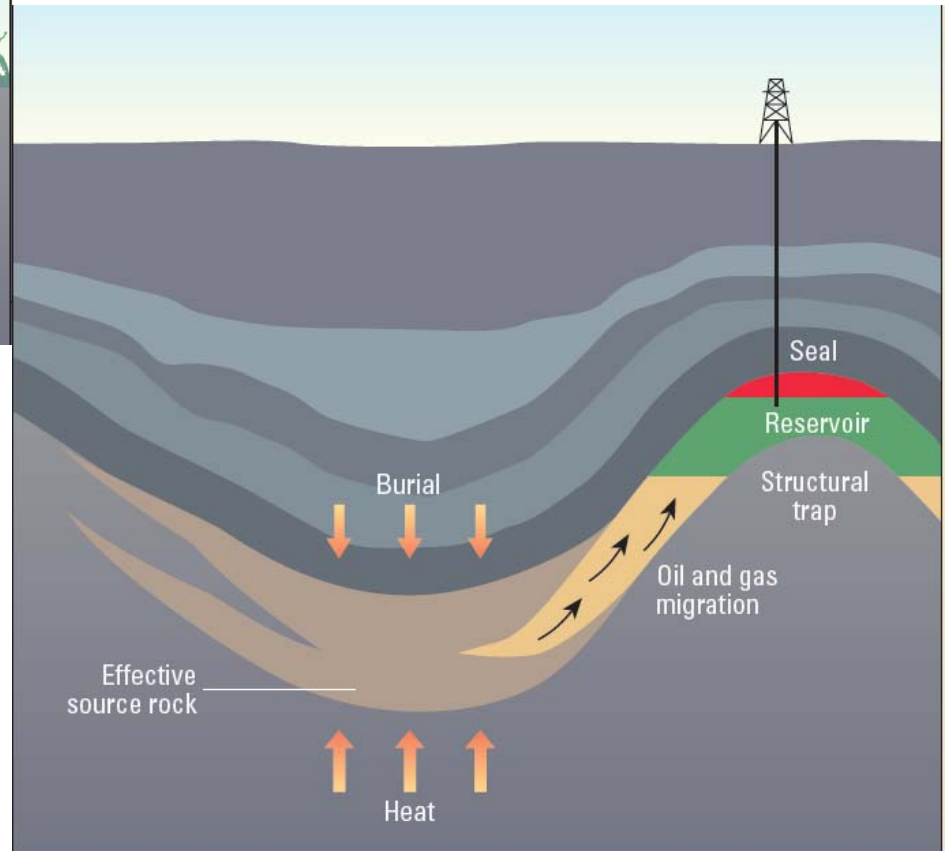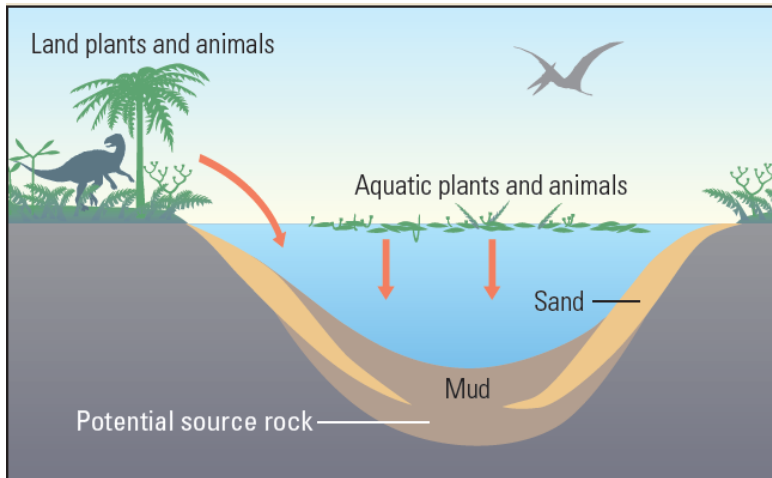
- 13:45 – Gruppearbeid Nr. 4

# Formation of oil and gas reservoirs

https://youtu.be/m5c_xPqDH7I

Formation of oil and gas reservoirs

Land plants and animals

Aquatic plants and animals

Sand

Mud

Potential source rock

Seal

Reservoir

Burial

Structural trap

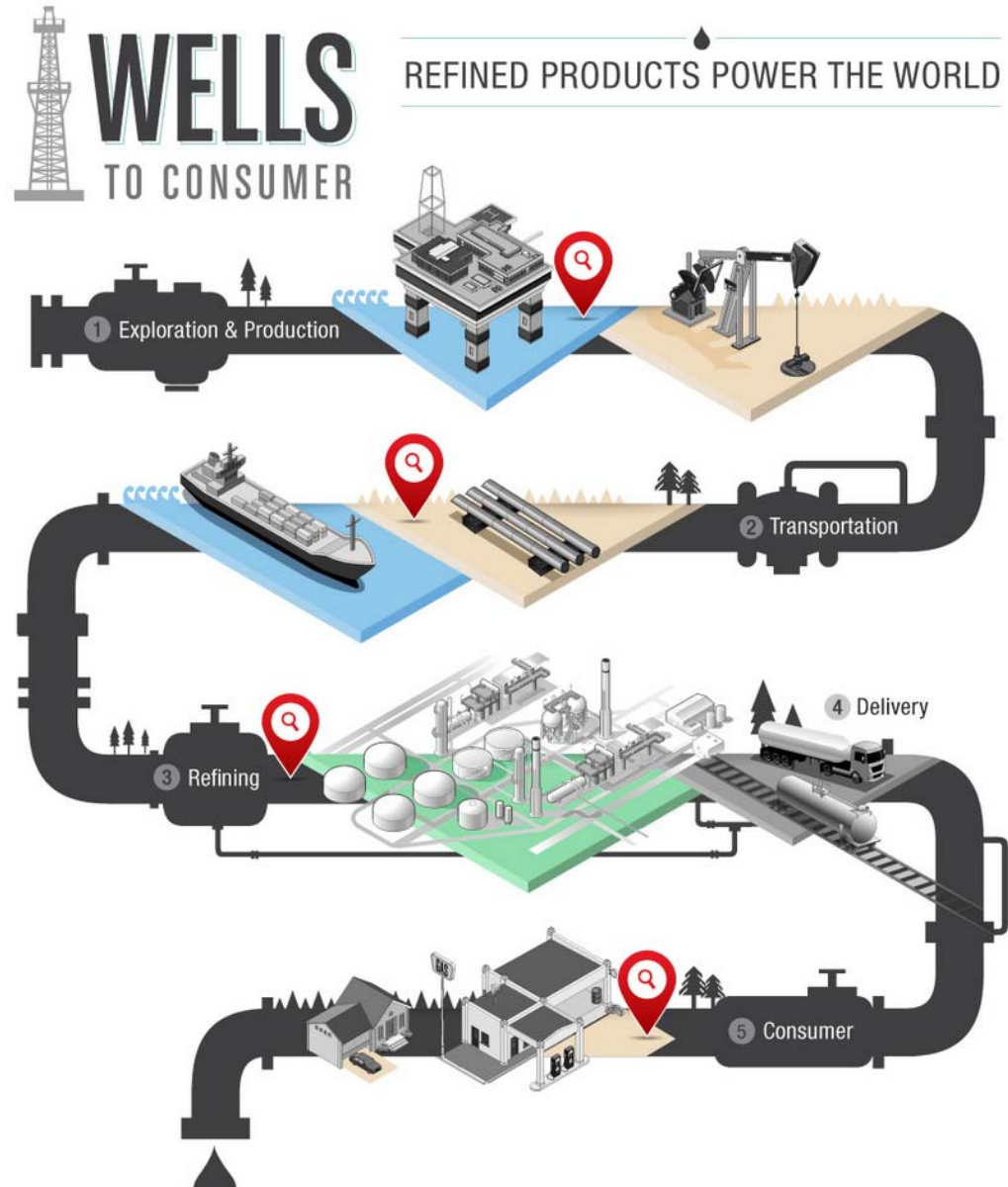Oil and gas migration

Effective source rock

Heat

^ Requirements for a petroleum accumulation. Sediment deposition in the past (*top*) may lead to hydrocarbon discoveries in the present (*bottom*). If the geologic elements—trap, reservoir, charge and seal—are present and the processes occur in the proper order (trap formation followed by hydrocarbon generation, migration and accumulation), a hydrocarbon reservoir may exist. In this case, the reservoir contains gas (red) and oil (green).
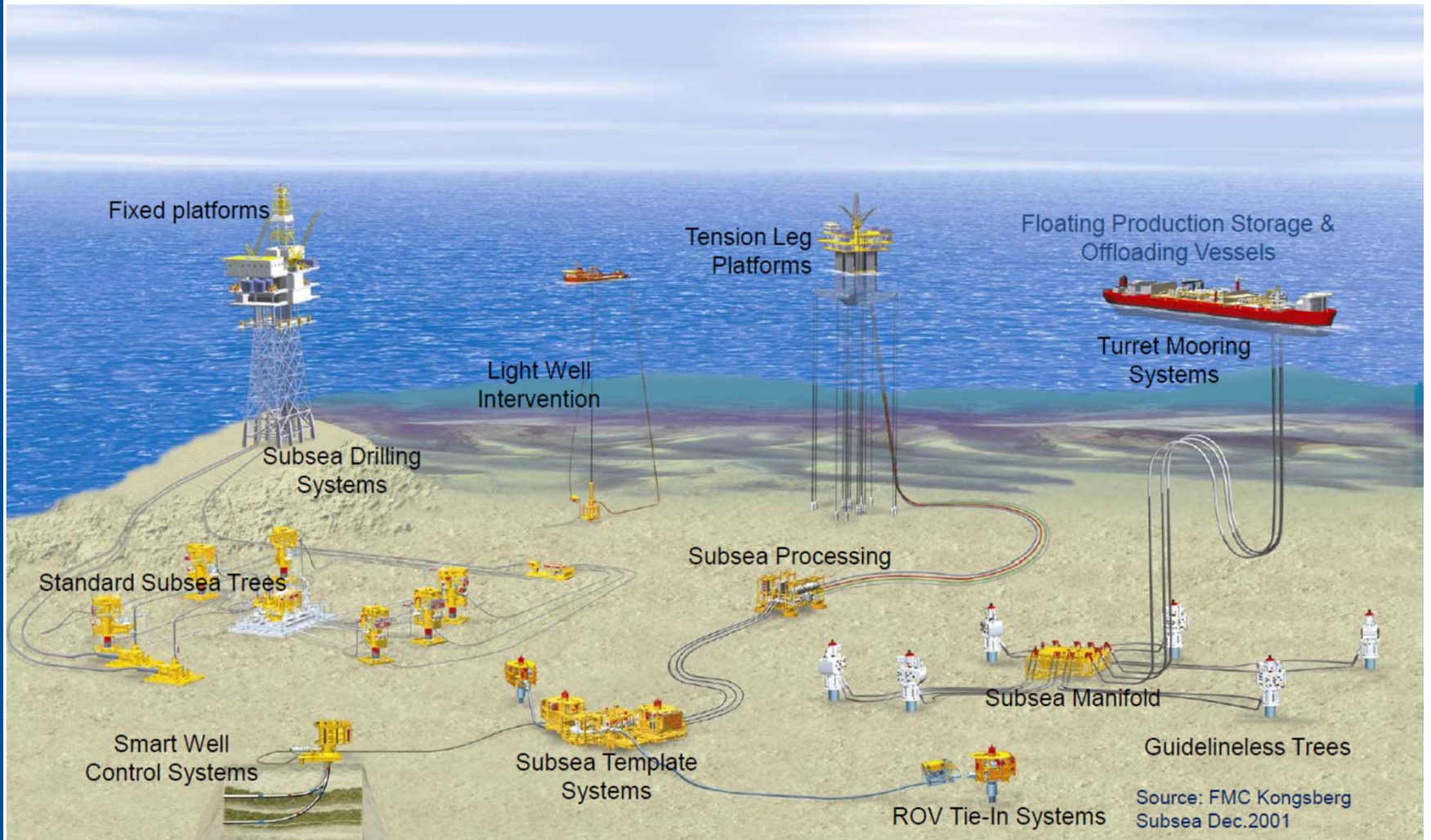
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Formation of oil and gas reservoirs
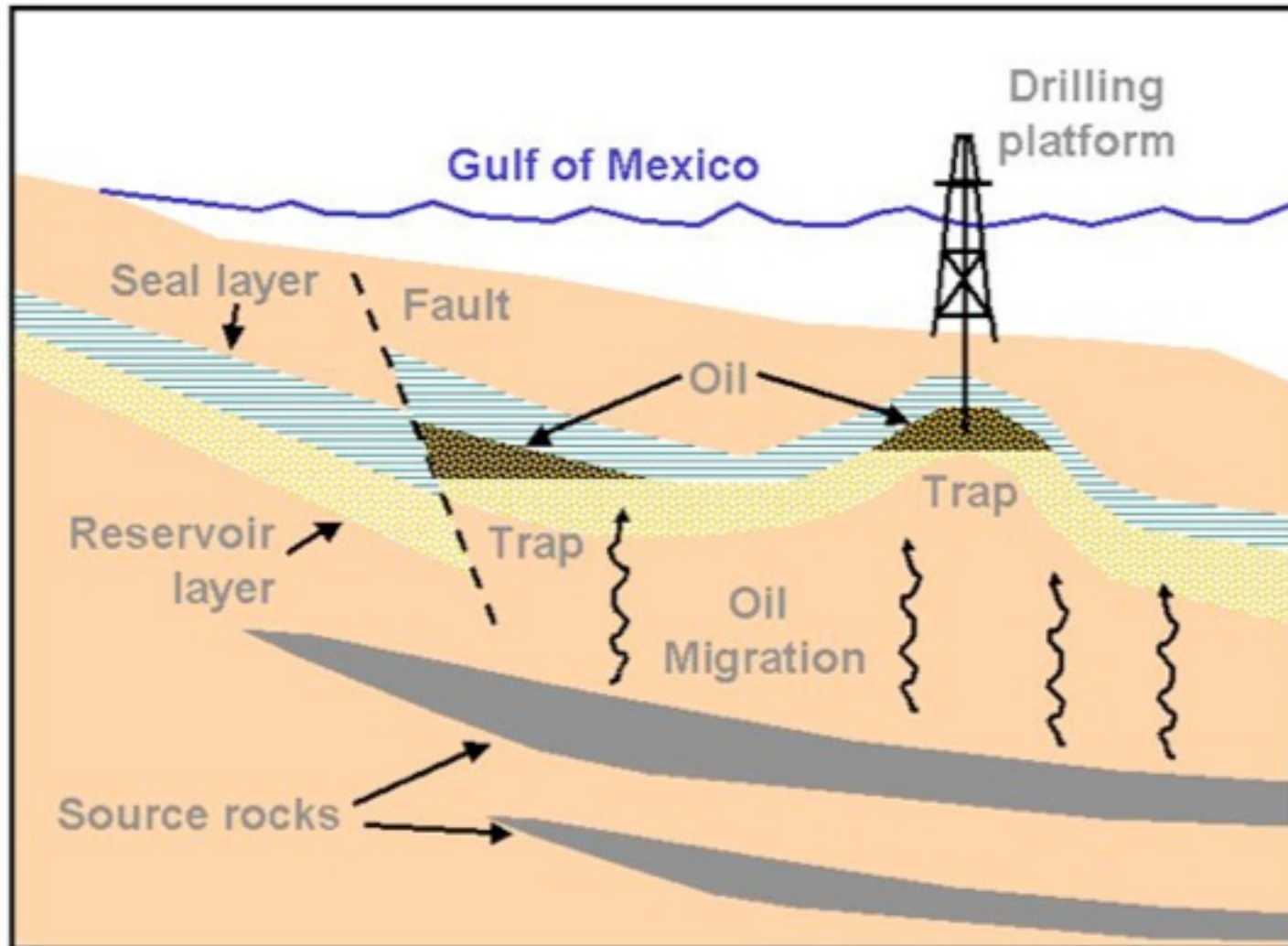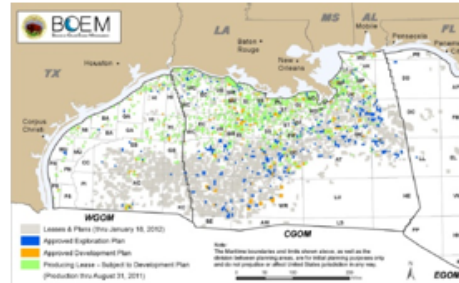
Oil and gas industry
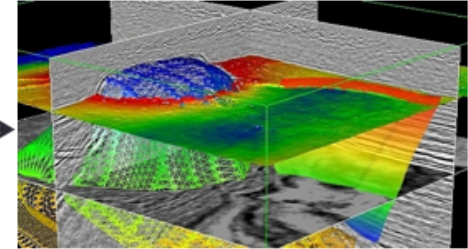
The oil and gas production system

Exploration and Production workflow

Seismic acquisition company records seismic data over area of interest (geophysicists: MS, PhD)
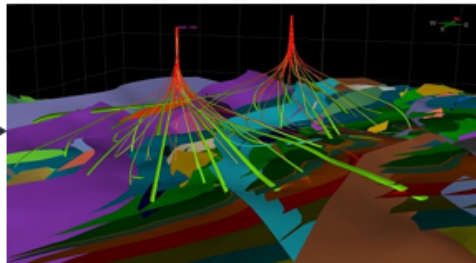

E&P company leases land from the government (landmen)

E&P company interprets data and determines a location to drill (geologists and geophysicists: MS, PhD)

Service companies drill the well and record technical data (engineers, geologists, geophysicists: BS, MS, PhD)
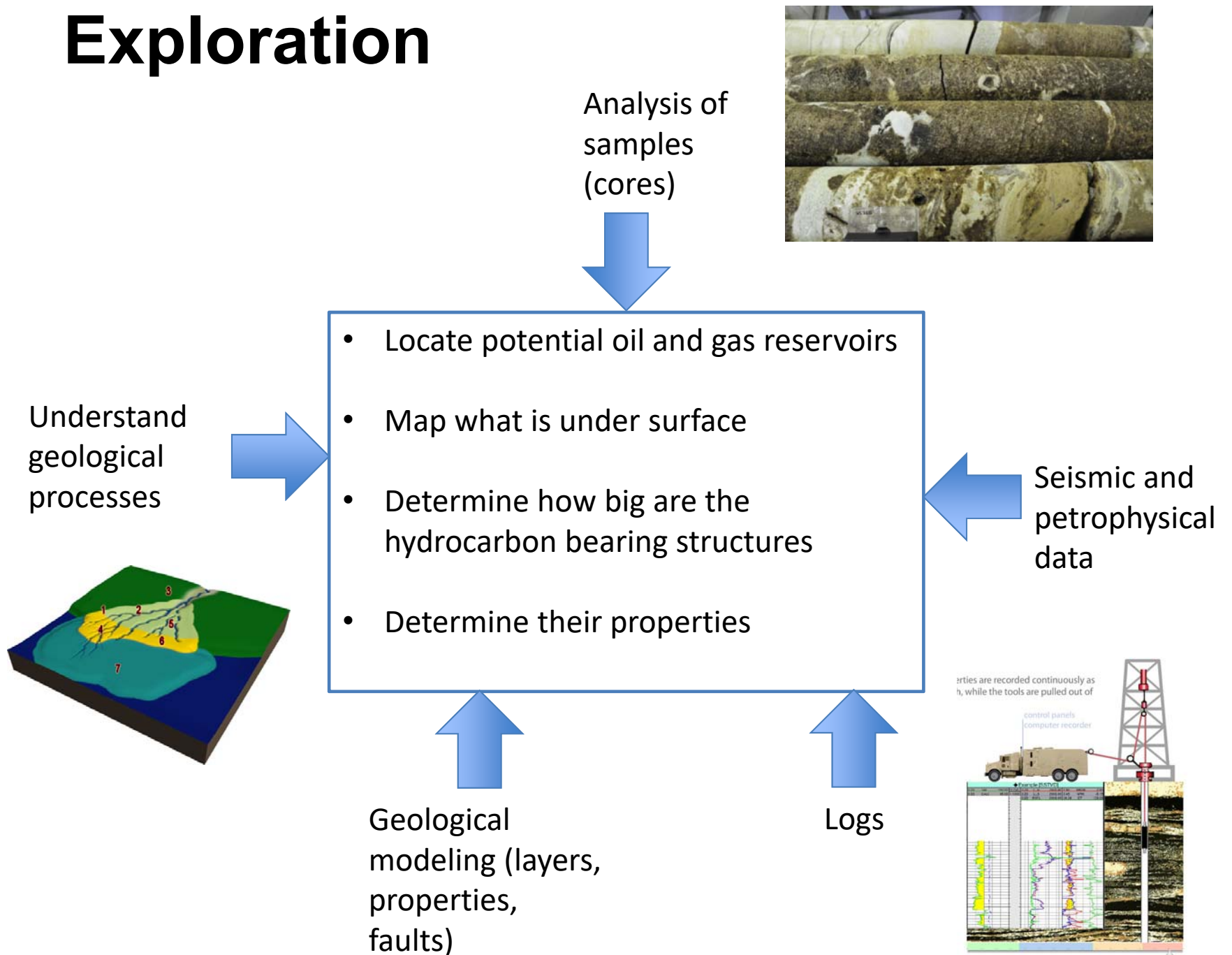

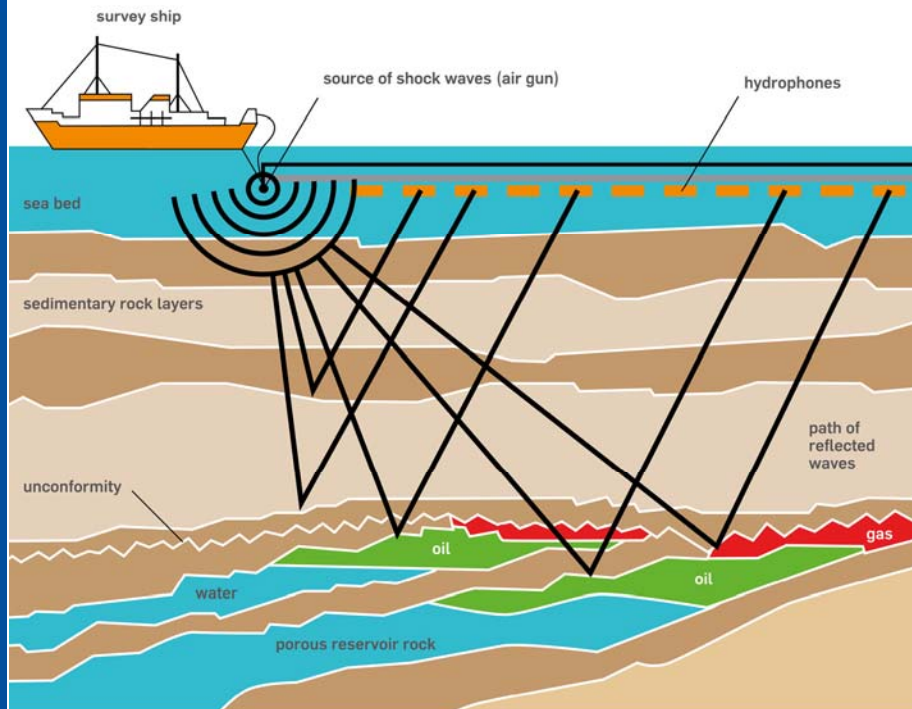If large enough reserves are proven, field development begins (engineers, geologists, geophysicists: MS, PhD)
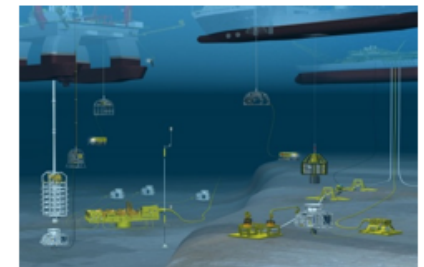
Production facilities, pipelines, storage facilities, and transportation are installed (Engineers)

Exploration

Analysis of samples (cores)

Understand geological processes

- Locate potential oil and gas reservoirs

- Map what is under surface

- Determine how big are the hydrocarbon bearing structures

- Determine their properties

Seismic and petrophysical data

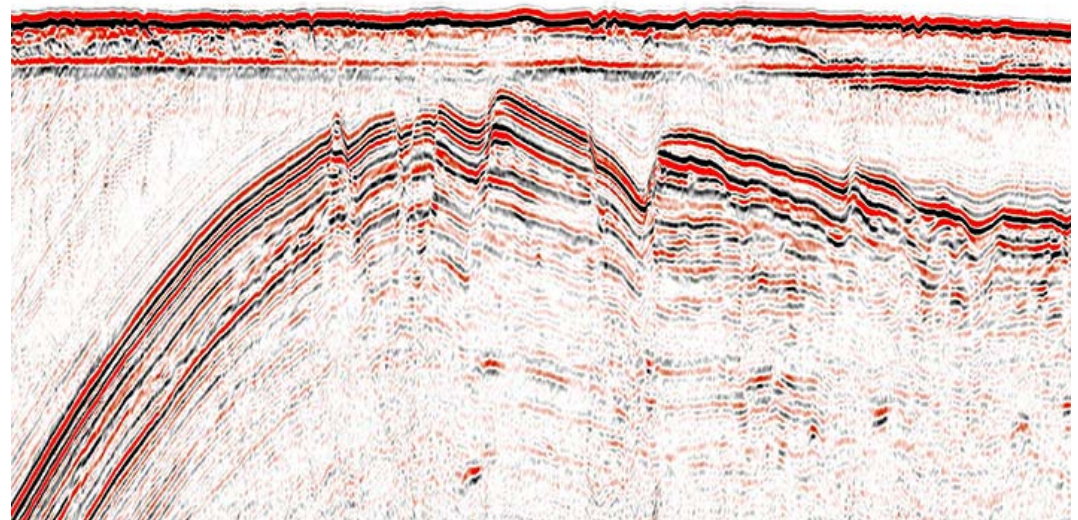Geological modeling (layers, properties, faults)

Logs

Seismic and applied geophysics

Huge amounts of data are generated!

Needs fast processing

Seismic and applied geophysics

Reservoir

How to produce the reservoir in an efficient and economic way?

Analyze the flow in the reservoir

Where to place the wells?

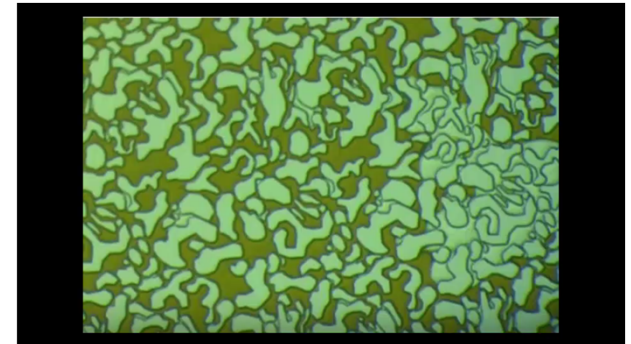How to get more from the reservoir? – Additional measures to help recovery

$$-\nabla \cdot \frac{\vec{v}_o}{B_o} - \frac{q_o}{\rho_{osc}} = \frac{\partial}{\partial t}\left(\phi \frac{S_o}{B_o}\right)$$
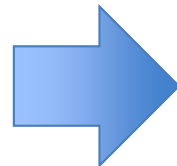
$$-\nabla \cdot \frac{\vec{v}_{wo}}{B_w} - \frac{q_w}{\rho_{wsc}} = \frac{\partial}{\partial t}\left(\phi \frac{S_w}{B_w}\right)$$

$$-\nabla \cdot \left[\frac{\vec{v}_g}{B_g} + \frac{R_{so}}{B_o}\vec{v}_o + \frac{R_{sw}}{B_w}\vec{v}_w\right] - \frac{q_g}{\rho_{gsc}}$$
$$= \frac{\partial}{\partial t}\left\{\phi\left[\frac{S_g}{B_g} + \frac{R_{so}}{B_o}S_o + \frac{R_{sw}}{B_w}S_w\right]\right\}$$

Use all available input

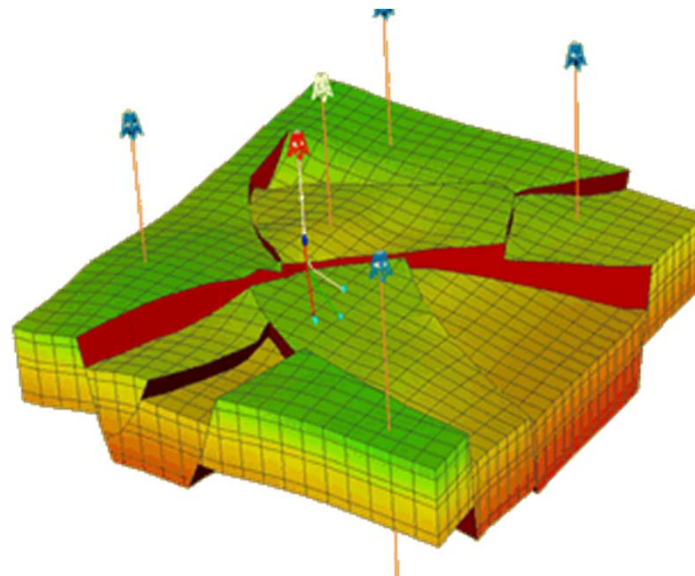Run sensitivity analysis using a virtual model of the reservoir and try different production alternatives on it!

Reservoir

Reserveestimater

NPV-økonomisk nåverdi

Utvinningsstrategi

Reservoar -simulering

Brønnplassering og -design
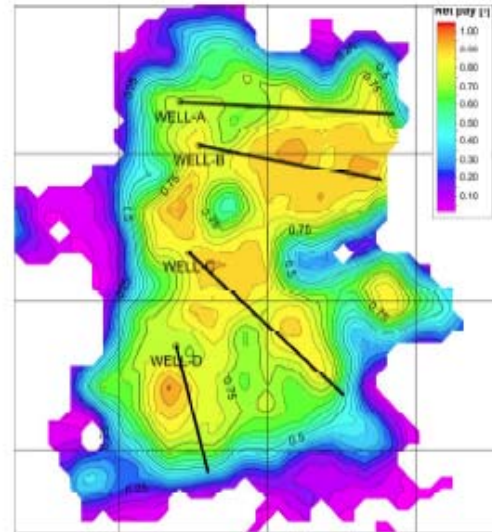
Trykk og temperatur

Petrofysiske egenskaper

Brønntesting
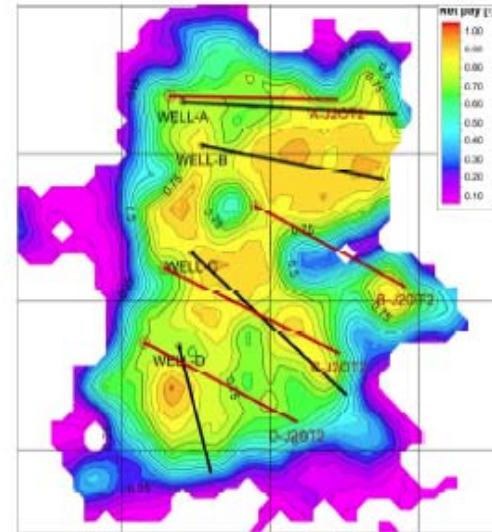
Fluidegenskaper

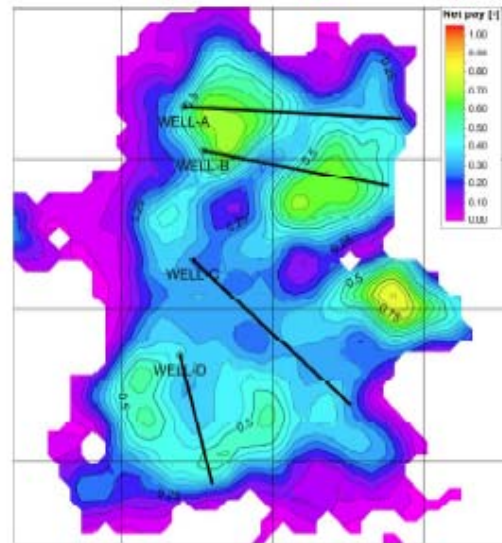Kjerneanalyse

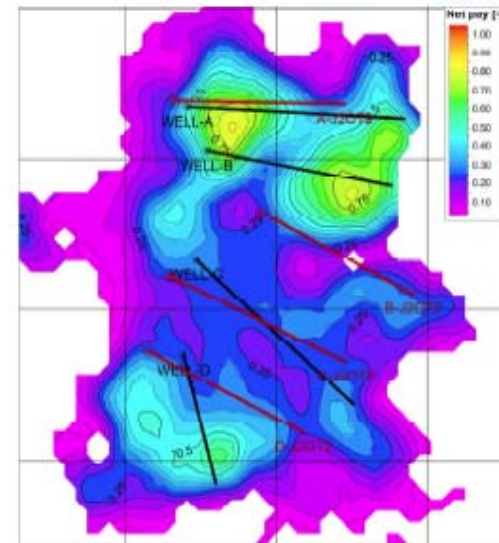Geologisk modell

Bergmekanikk

Reservoir – well placement

(a) BASECASE HuPhiSo map, 0 days.

(b) JNT2OPT2 HuPhiSo map, 0 days.

(e) BASECASE HuPhiSo map, 5174 days.
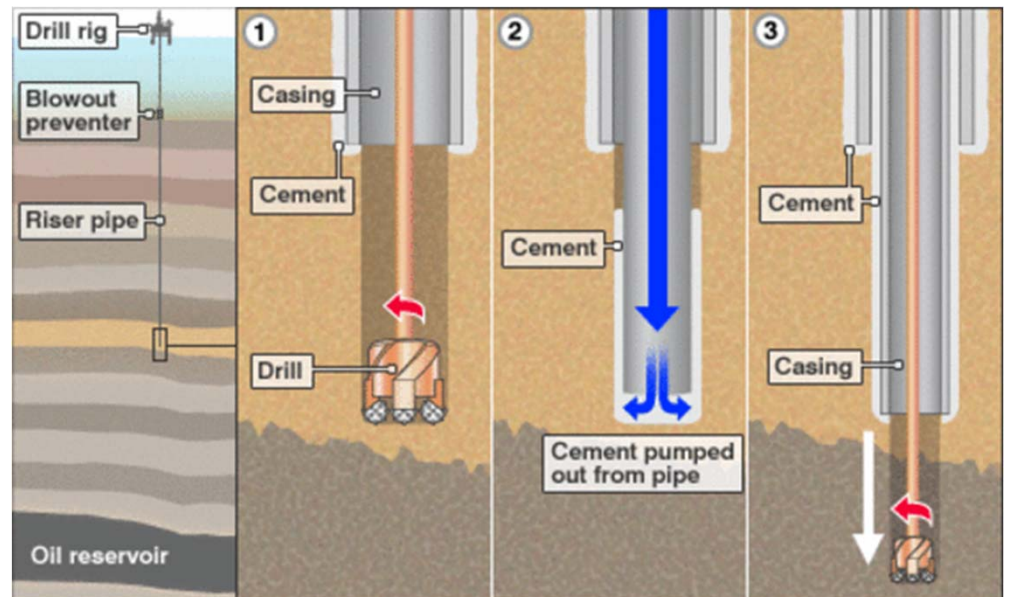
(f) JNT2OPT2 HuPhiSo map, 5174 days.

Reservoir – Visualization of complex structures
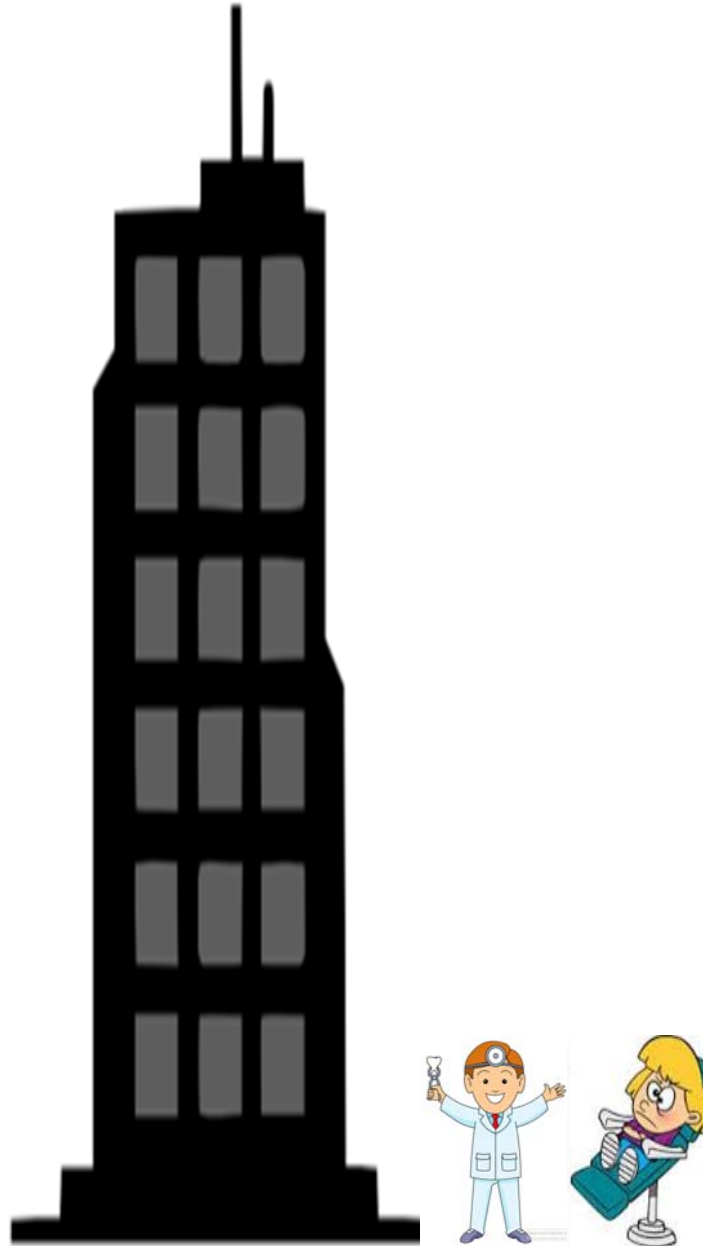
Drilling

- Design and drill the wells in a controlled and safe manner!
  - Avoid problems and know how to solve them

- Do not damage the reservoir

- Increase the information about the reservoir (rock properties, fluid properties)
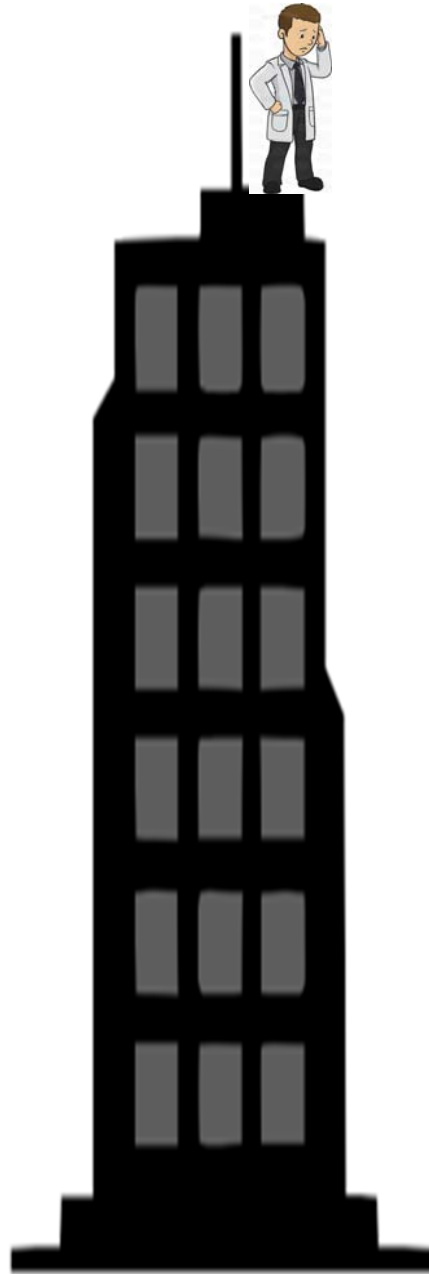
- Control

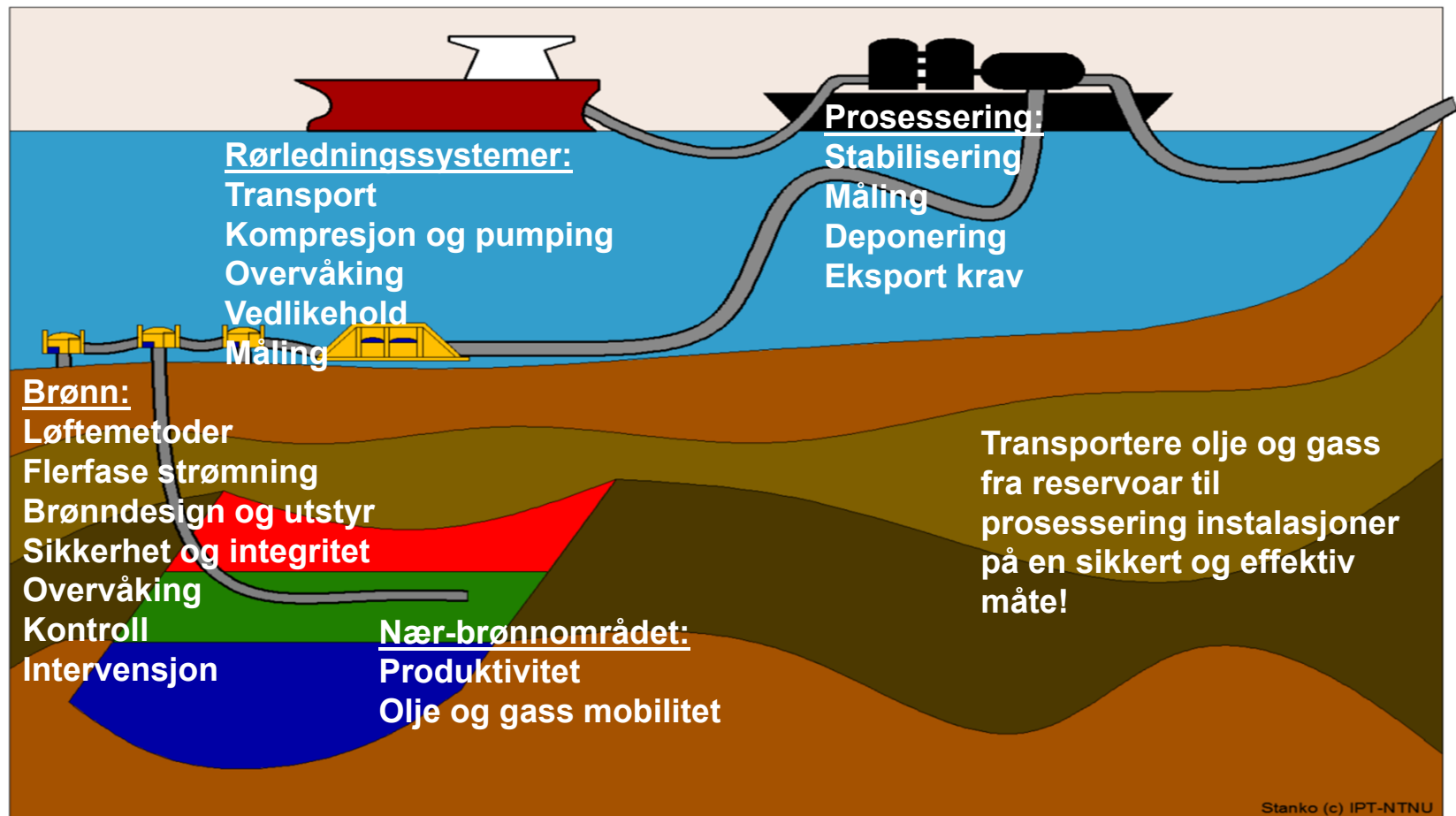- Analysis of while-drilling data

Challenges – remote operations

Challenges – remote operations

Challenges – remote operations

Production engineering

Rørledningssystemer:
Transport
Kompresjon og pumping
Overvåking
Vedlikehold
Måling

Prosessering:
Stabilisering
Måling
Deponering
Eksport krav

Brønn:
Løftemetoder
Flerfase strømning
Brønndesign og utstyr
Sikkerhet og integritet
Overvåking
Kontroll
Intervensjon

Nær-brønnområdet:
Produktivitet
Olje og gass mobilitet

Transportere olje og gass fra reservoar til prosessering instalasjoner på en sikkert og effektiv måte!

Stanko (c) IPT-NTNU

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What does a petroleum engineer do?

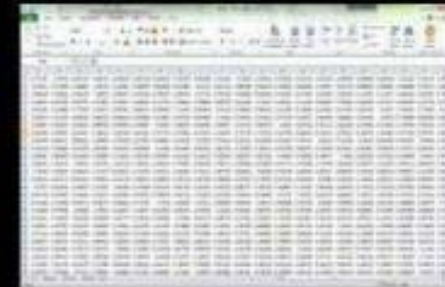What my friends think I do

What my mom thinks I do

What society thinks I do
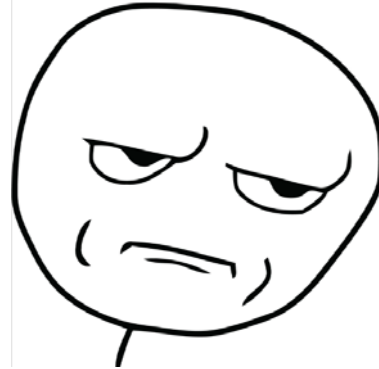
What the government thinks I do

What I think I do

What I actually do

https://www.petroleumengineers.ru/sites/default/files/166900_2741492813353_1138437774_32151468_487288168_n.jpg

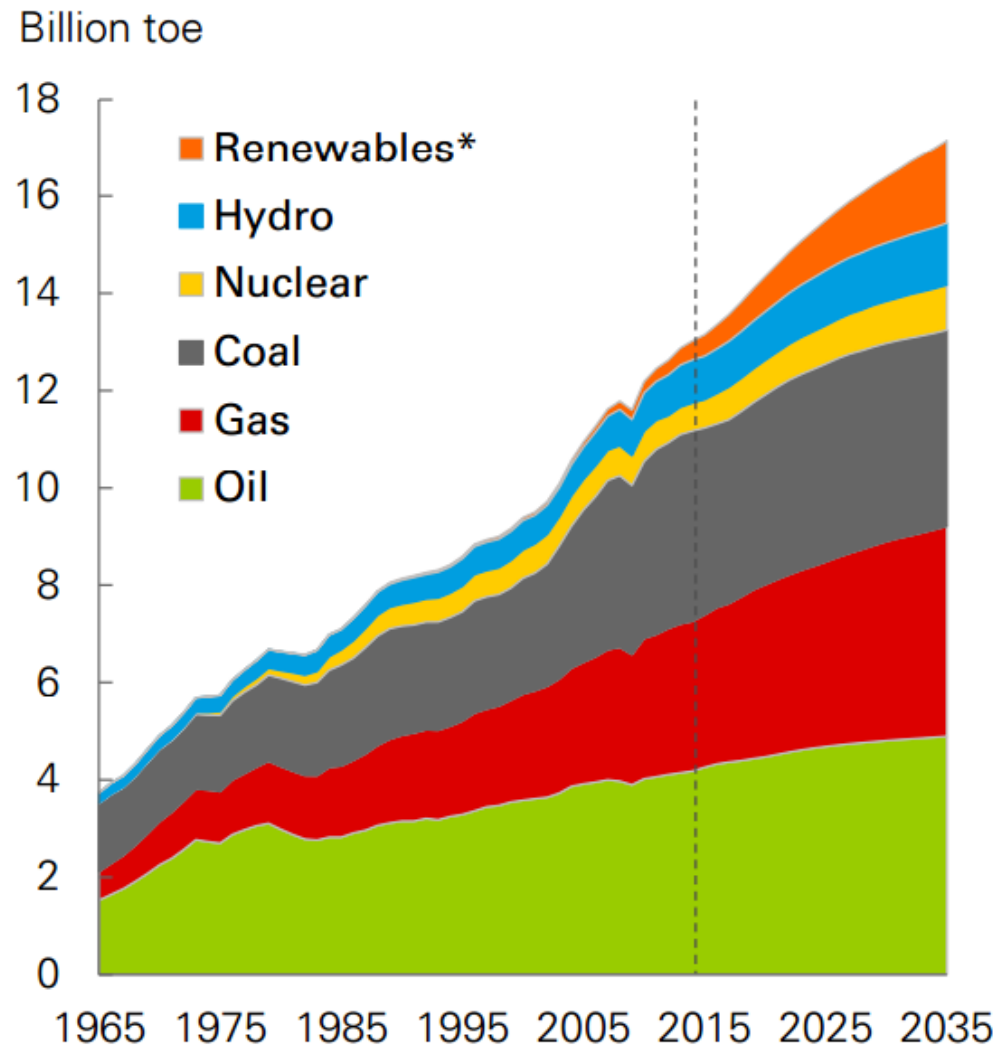# What does a petroleum engineer do?..

seriously now

Our responsibility: To ensure the supply of the most used energy source (oil and gas) to society

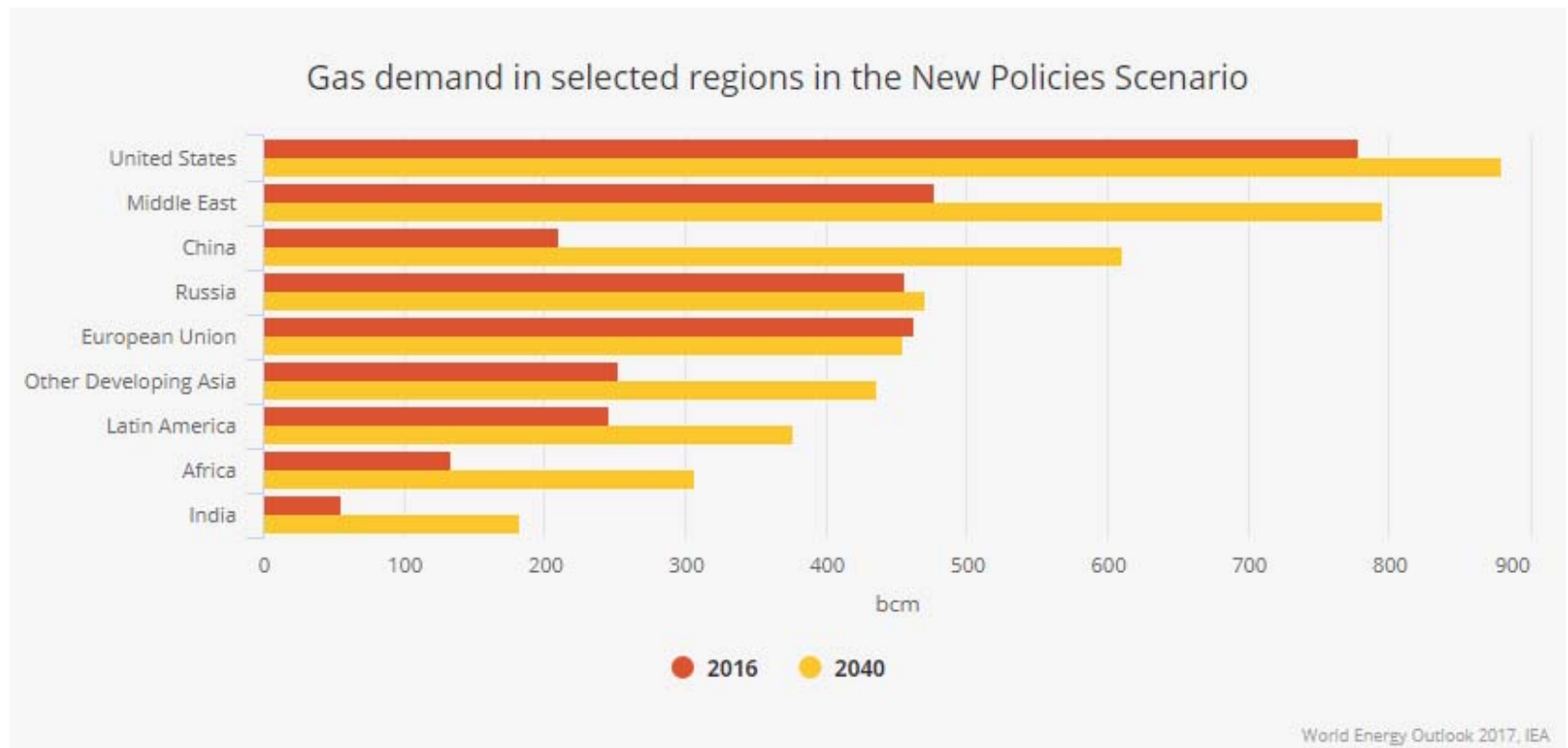With great power comes great responsibility.

World energy demand

Primary energy consumption by fuel

Billion toe

Legend:
- Renewables*
- Hydro
- Nuclear
- Coal
- Gas
- Oil

*Renewables includes wind, solar, geothermal, biomass, and biofuels

World energy demand

Gas demand in selected regions in the New Policies Scenario

Projected production

Oil and gas production from Norway – by life cycle
Thousand boe per day

Energy-sector CO$_2$ emissions

- Early peak in emissions
- Net-zero by the end of the century

Hydrocarbon reserves in Norway

26

Hydrocarbon reserves in Norway

Produsert
48%

Gjenværende
52%

21% reserver
6%   ressurser i felt
5%   ressurser i funn
20% uoppdagede ressurser