



Statoil



Drilling depleted reservoirs

Offshore Mature Fields – Extended Life and IOR Rotvoll, 8. June 2017

Project leader Therese Scheldt

Classification: Open

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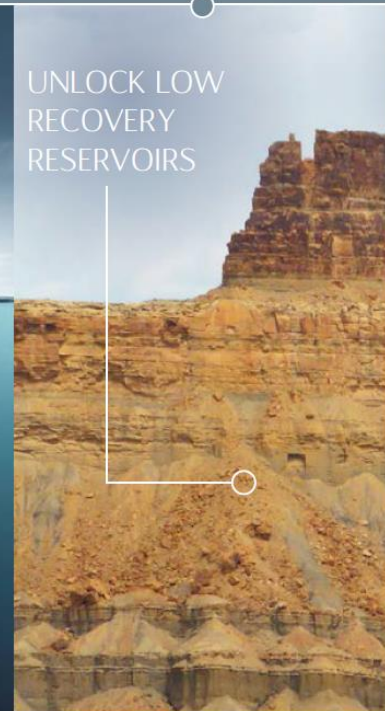
TECHNOLOGY TO SHAPE THE FUTURE OF ENERGY

Statoil's technology strategy

INNOVATION

CROSS-DISCIPLINE SOLUTIONS

DIGITALISATION



Background

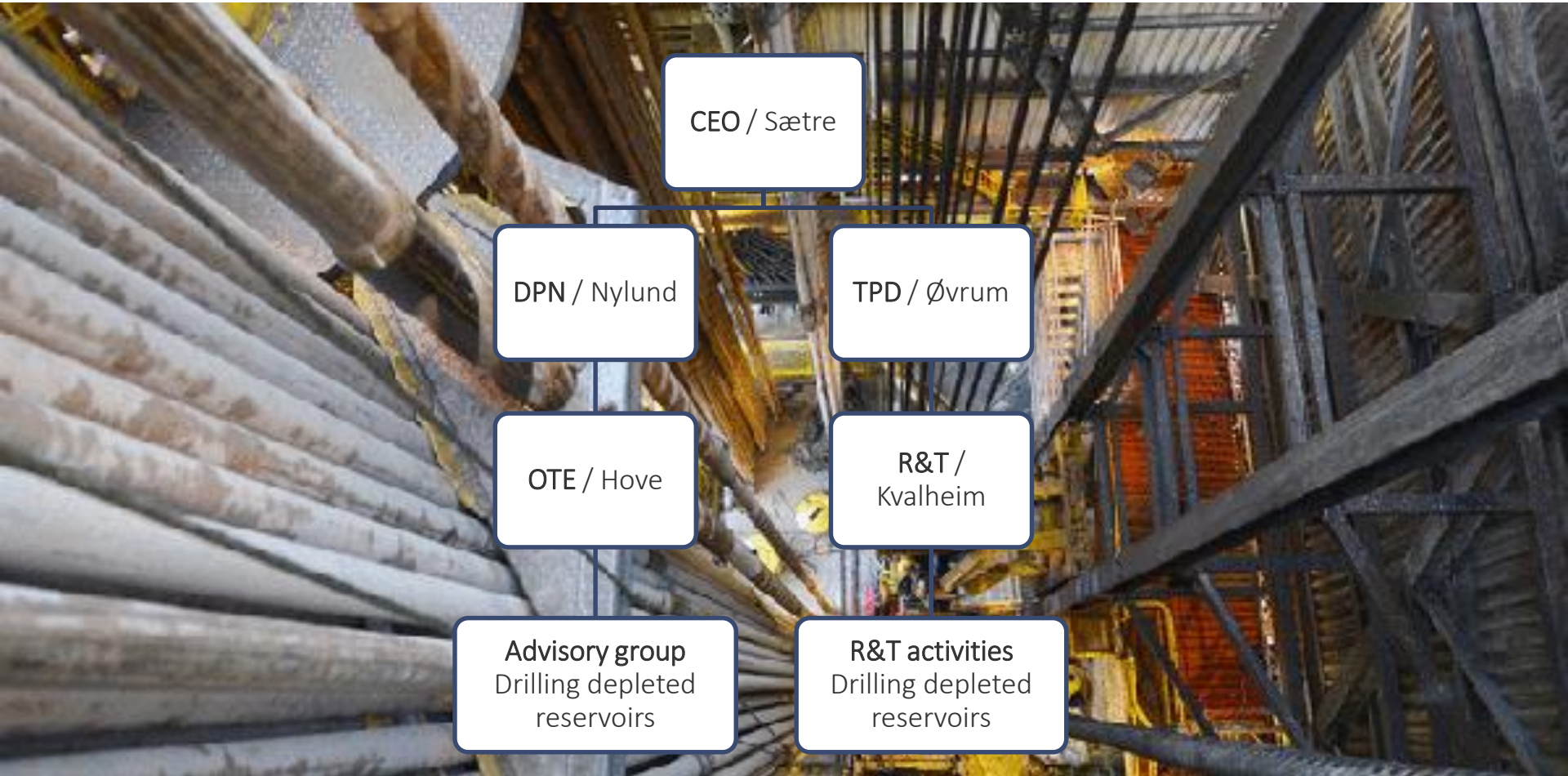
- Infill drilling important for increased oil and gas recovery
- Mature fields: non-existing or very limited drilling window
- Approximately 20 % of DPN's IOR volumes are connected to infill drilling and depletion challenges *
- Industry challenge

* DPN IOR Strategy 2016

Well target mapping database

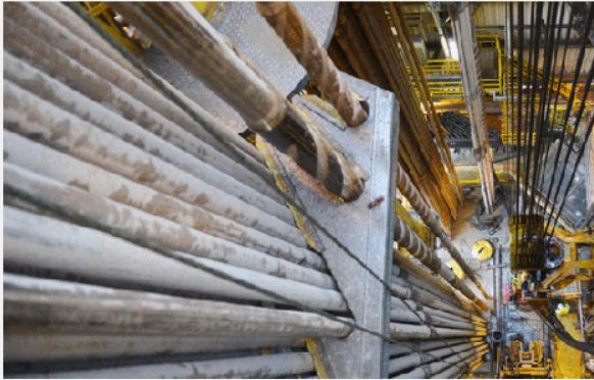
- Increase knowledge of future DPN well targets portfolio:
 - New technology needed to drill the targets
 - Future well design solutions needed to drill the targets in a cost effective manner
 - Potential project stoppers to be solved by future improvement projects
 - Boost IOR

Drilling depleted initiatives in Statoil



Innovation campaign

Drilling in Depleted Reservoirs



For several mature fields, drilling and completion of new wells is likely to become restricted by depletion at some point. We need YOUR help to come up with ideas that will excel our ability to drill in depleted reservoirs.

Background

Infill drilling is an important measure for increasing oil and gas

1. Cost-efficient downhole stress measurements

We are looking for solutions, methods and/or technologies which would

- 1) improve the existing procedures / methods to measure formation stress to enable open hole measurements
- 2) enable real-time - continuous or intermittent - determination of the formation stress while drilling
 - a. brief interruptions of the ongoing operation to acquire measurements are acceptable
 - b. here we are primarily looking for solutions which does not involve actual fracturing of the formation but where the formation stress is estimated from “log” measurements.

2. Prevention and curing of fracture related losses

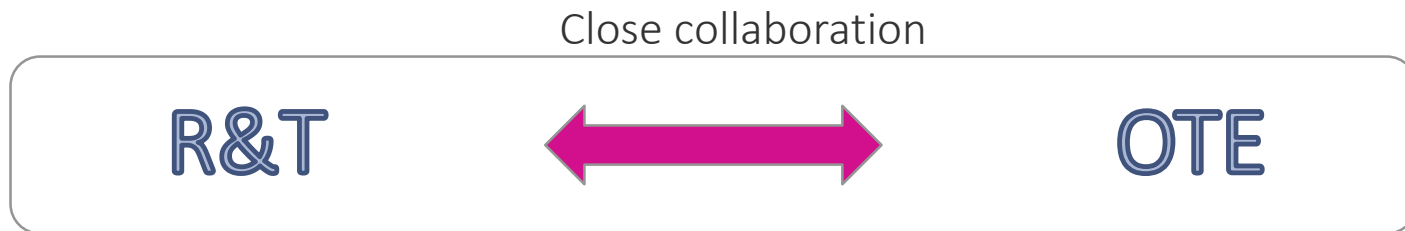
We need a solution that let us quickly plug and drill ahead once a loss incident occurs. If we can fix this, the majority of our depleted reservoirs would be very drillable!

We are looking for solutions, methods and/or technologies which would

- 1) *prevent* fracture related losses
- 2) enable *faster detection and isolation* of fracture related losses
- 3) enable *fast plugging / curing* of fracture related losses

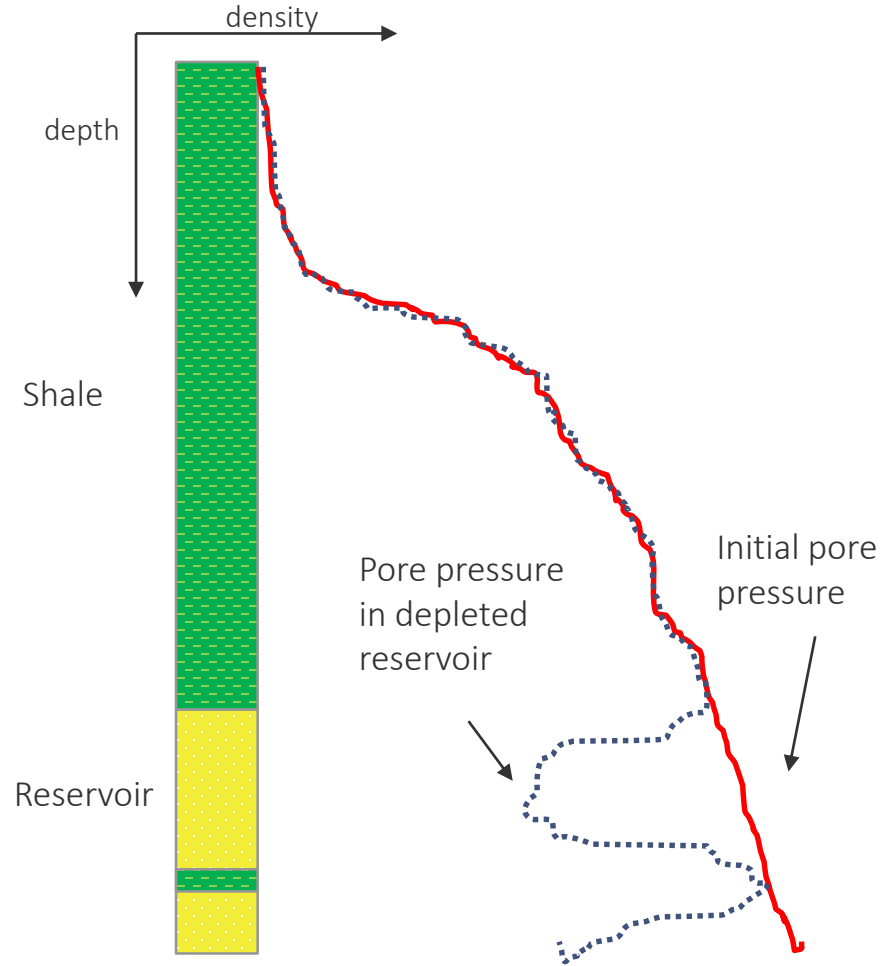
Main activities

- Secure fundamental understanding of the challenges
- Evaluate available technology to mitigate challenges
- Establish a relevant research portfolio
- Advise and support assets in re-evaluation of drilling practice and well concept
- Communicate recommendations across organization



Pressure depletion

- Reduction in pore pressure as a result of producing gas and oil
- Reduction in volume -> reduction in pressure
- Pore pressure may be the initial one in shale zones
- In permeable reservoir zones, the reduced pore pressure is established almost instantaneously



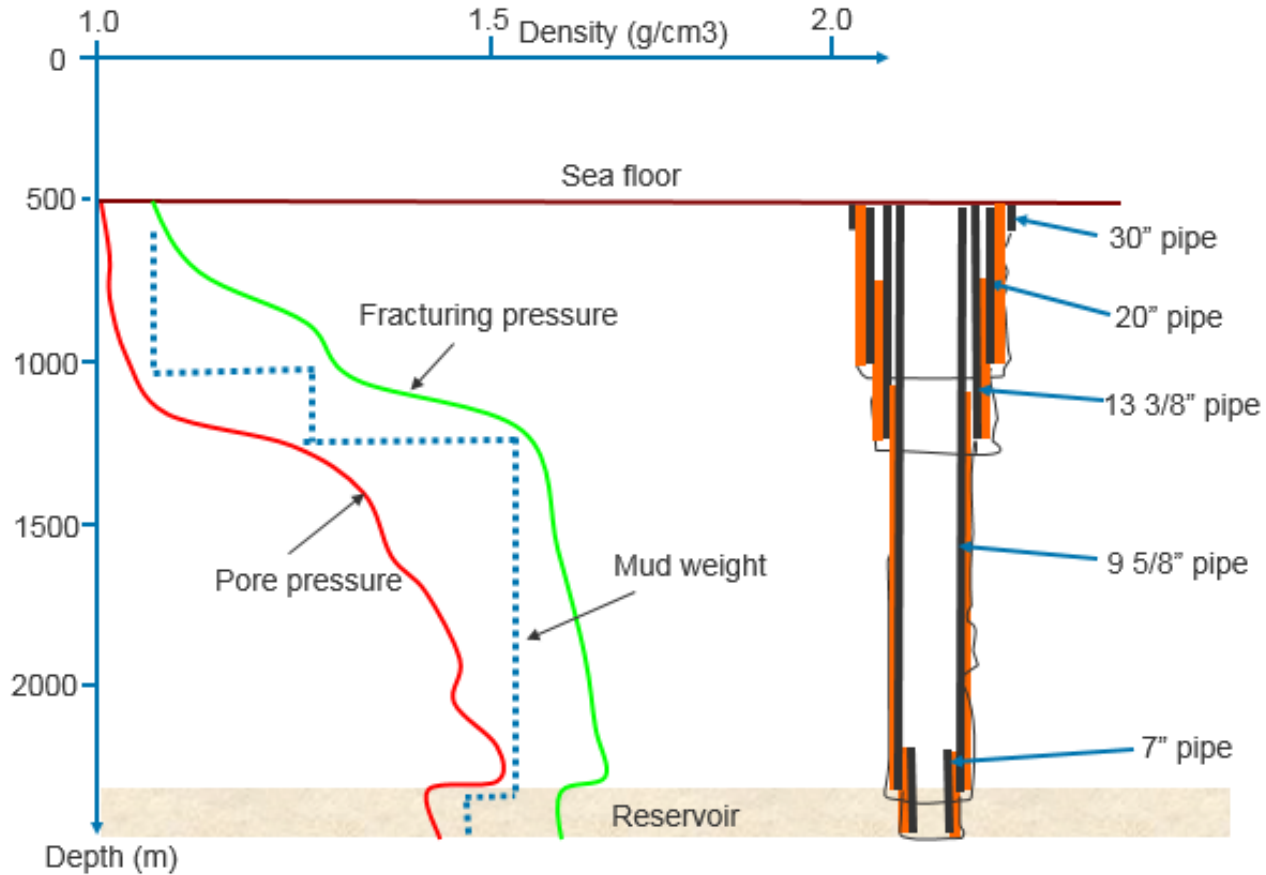
Essence of challenge



- Optimize the operational drilling window
- Avoid uncontrolled risks

Is it possible to identify a “safe” operational window?

Drilling window



Should be easy to solve.....

YES



WHY?

NO



- Bounding curves are very uncertain
- The challenge is highly cross-disciplinary

What influences drilling in depleted reservoirs?

Pore pressure

Rock stresses

Fracture pressure

Shear failure / bore hole stability

Loss mechanisms

Geological complexity

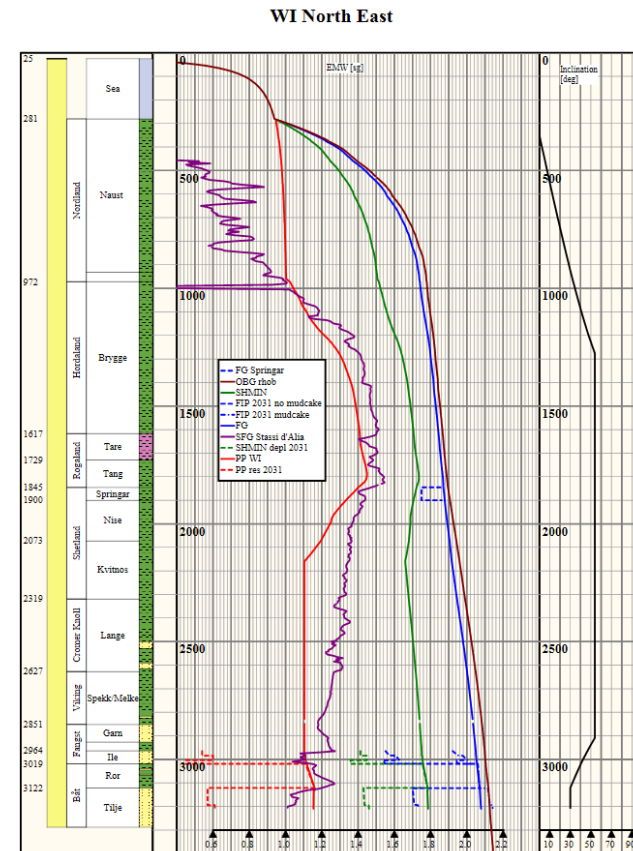
Drilling fluids

Filter cake and well productivity

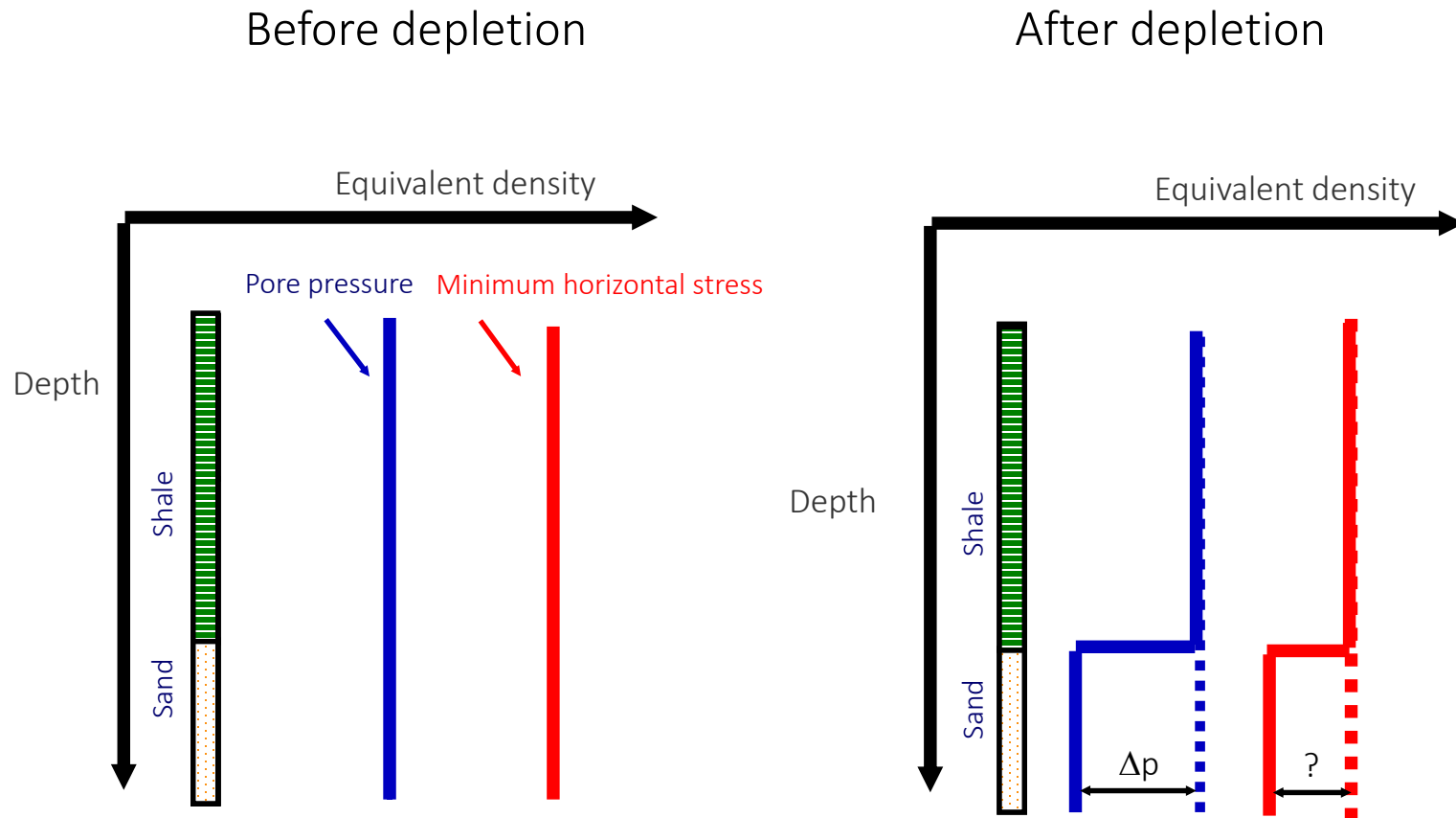
Drilling technology

Operational practice

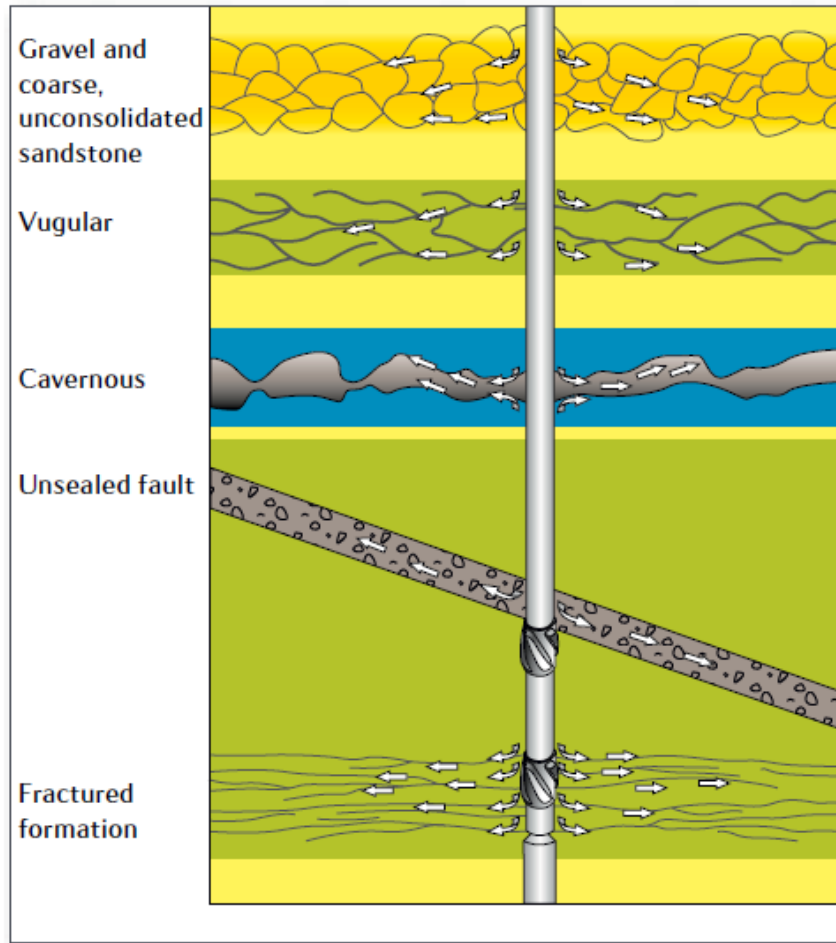
Production strategy



Pressure depletion and stress changes

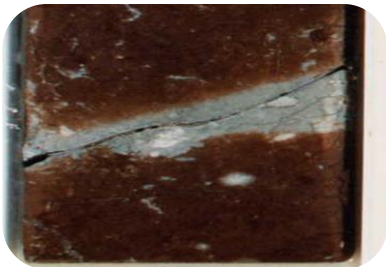


Natural losses in various formations



From: Quick reference guide BEST PRACTICE drilling operations

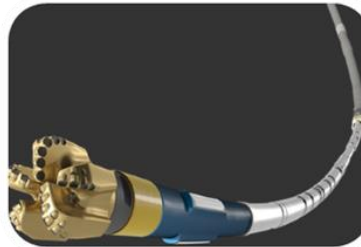
Drilling depleted toolbox



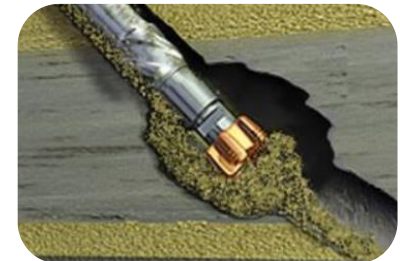
Methodology



Improvement projects

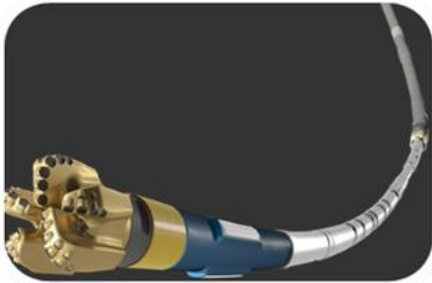


Existing technology



Ongoing R&T projects

Existing technology and ongoing projects



Existing technology

- Particles in drilling fluid
- Well construction
- Increased downhole knowledge and control
- Increased reservoir knowledge
- Pressure control
- Mitigate risk

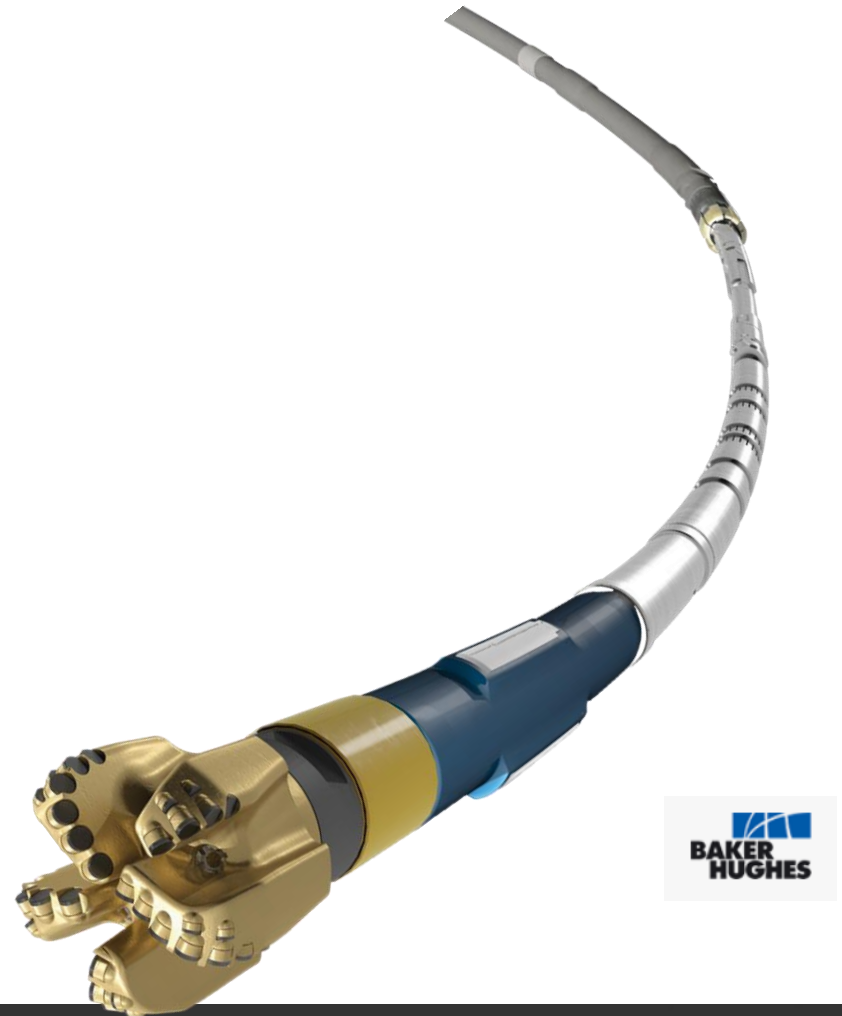


Ongoing R&T projects

- Well construction
- Increased downhole knowledge and control
- Pressure control
- Decision support
- Cross disciplinary activities

Technology example - Steerable drilling liner (SDL)

- Used successfully to drill “un-drillable” sections in several wells
- The SDL wells are among Statoil’s best producers drilled the last five years
- Next generation – the one trip system will be introduced 2018



Success factors



Statoil. The Power of Possible

Drilling depleted reservoirs

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