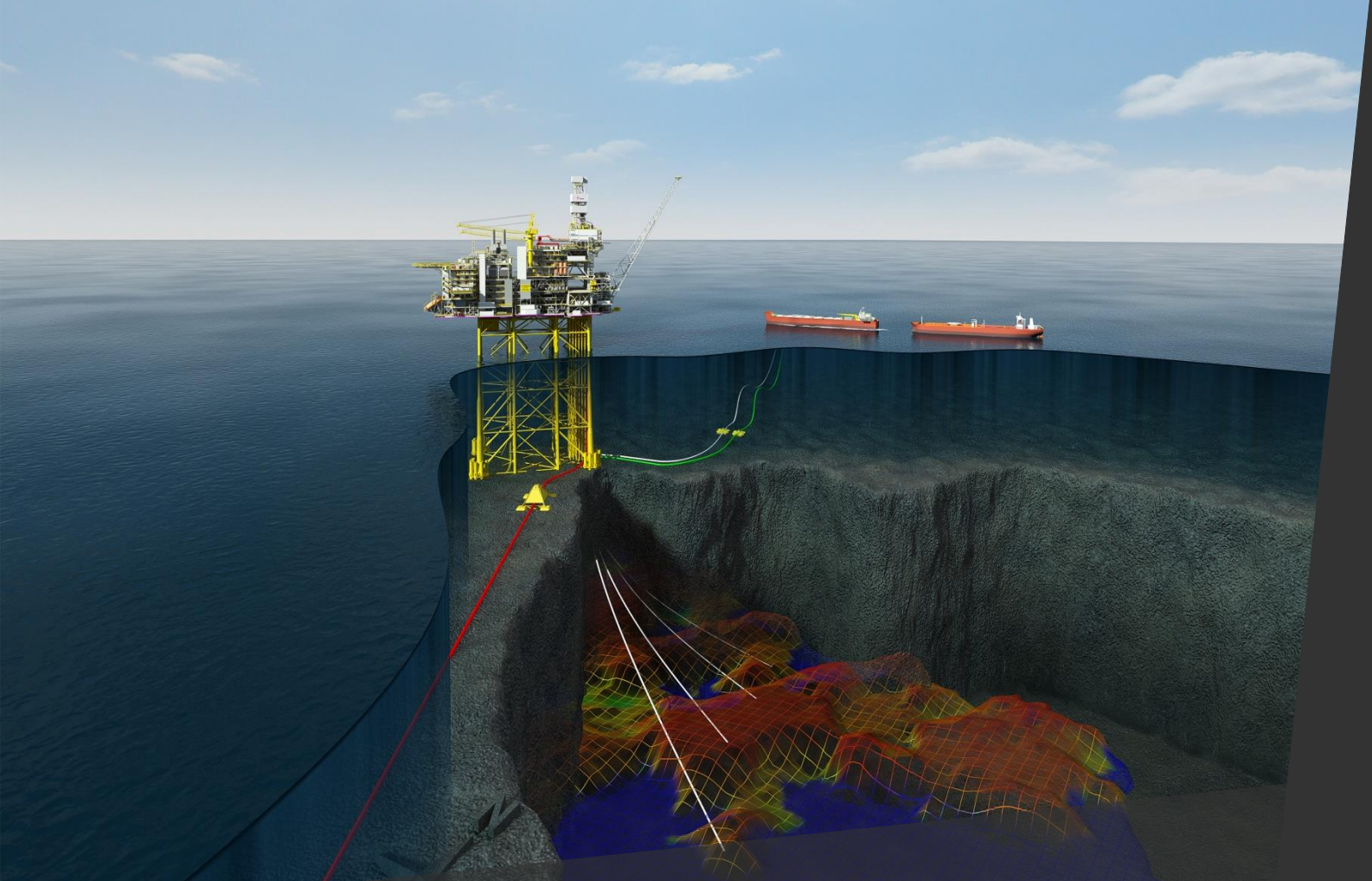
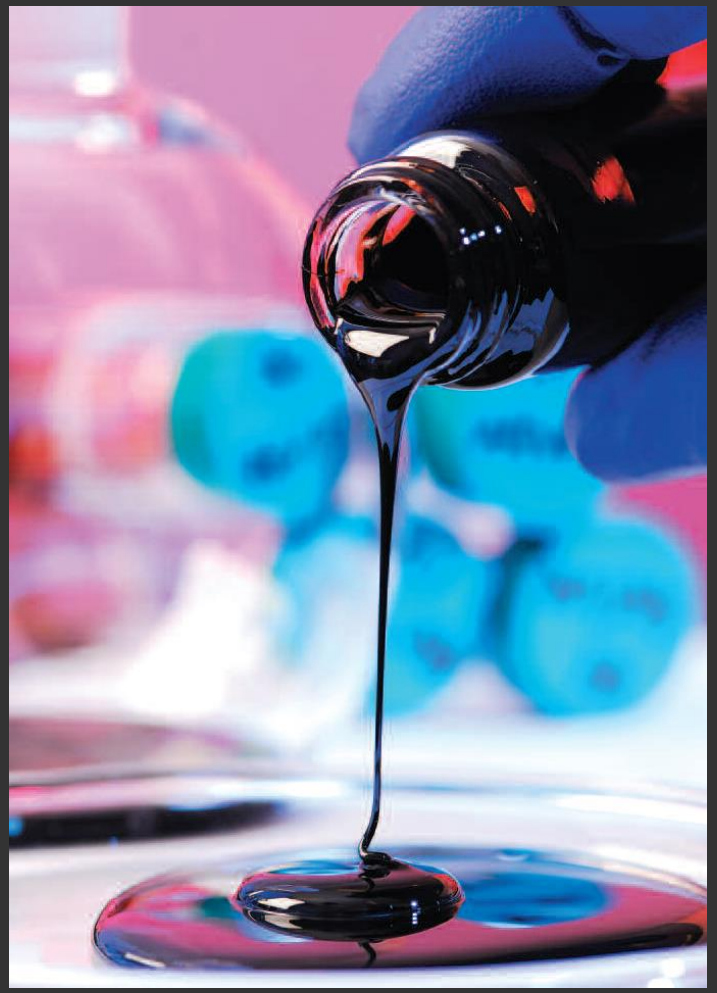


Mariner – how new technology and collaboration are adding value in a low oil price environment

Presented by Simone Silcock, Nick McArdle, Adaeze Iheobi and Jason Iyeke, Statoil Production UK Ltd. SPE 24th February 2016

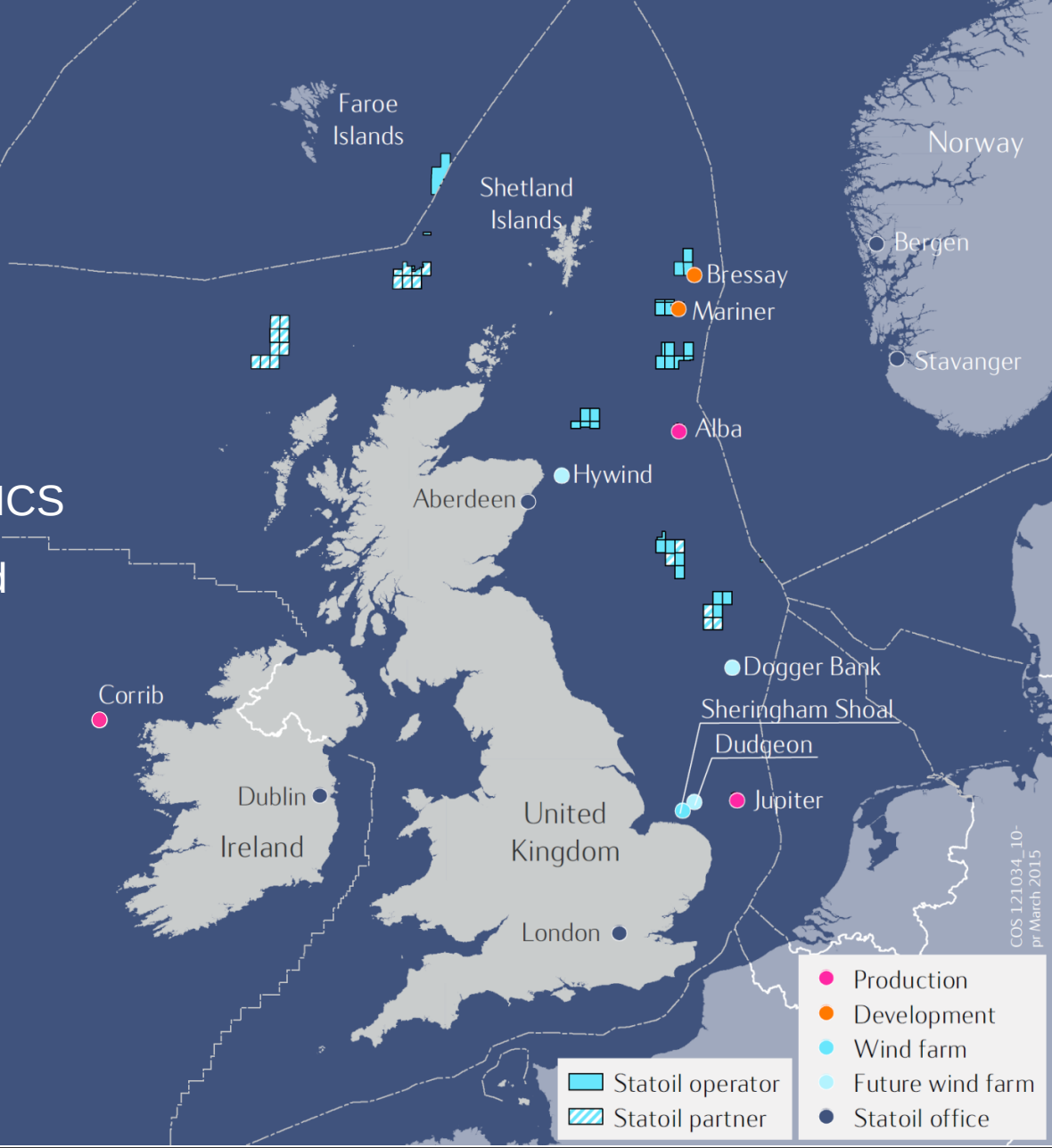
Outline

- Statoil at a glance
- The Mariner Field
- Improved seismic imaging
- AVO and Heimdal interpretation
- Fast Model Update (FMU)
- Heimdal Drainage Strategy
- Challenges
- Well/Rig design
- STEP process
- Summary



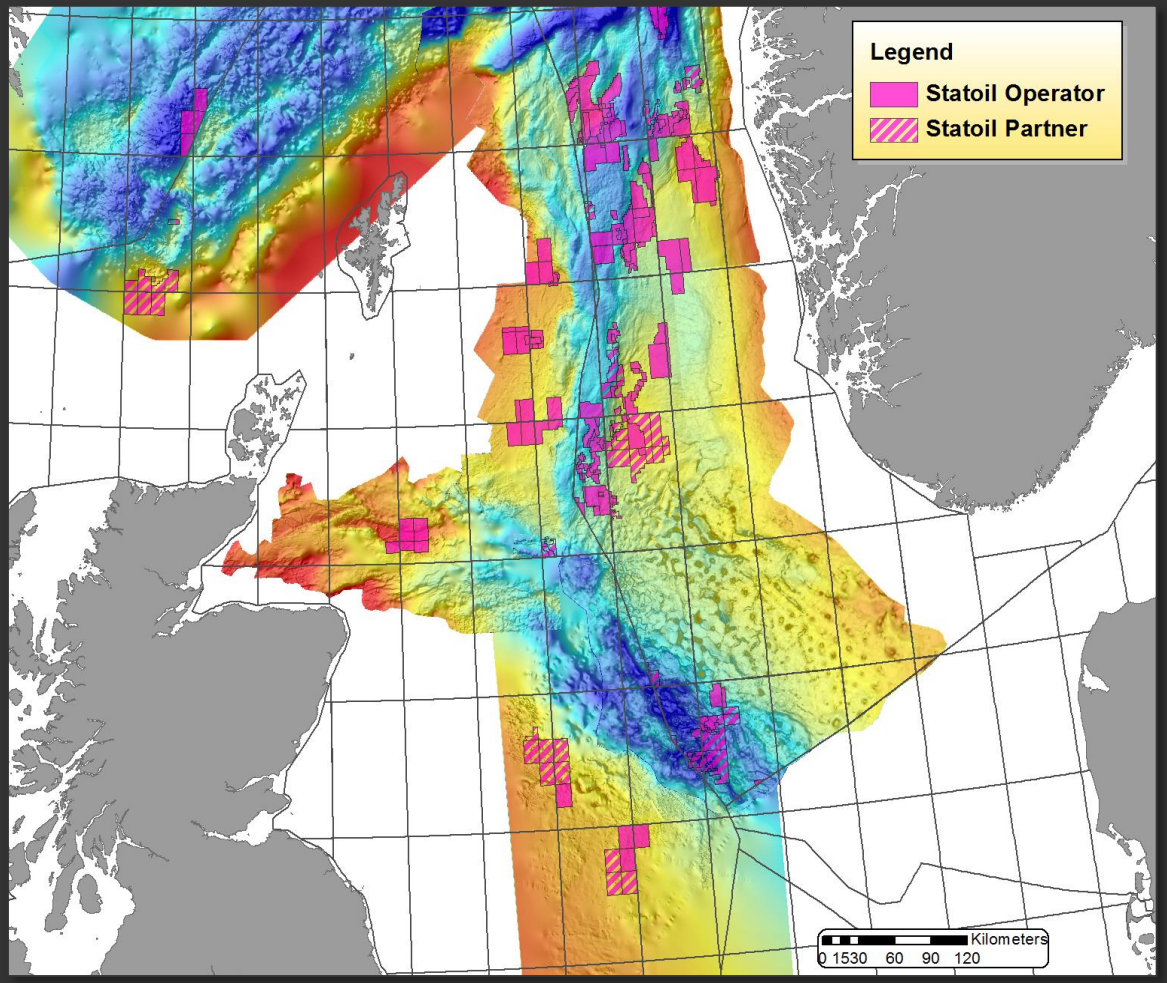
Statoil at a glance

- International energy company with operations in 36 countries
- 40+ years experience on the NCS
- Equity production ~2 mill boe/d
- Step-change as UK operator
  - Mariner and Bressay projects
  - Ramping up exploration
  - Offshore wind projects

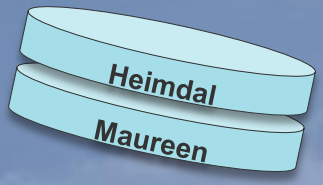


Expanding our North Sea core area

- Renewed UKCS focus
- One North Sea approach
- 20+ UK exploration licences, most of them operated
- Concentrating on frontier type opportunities



The Mariner field



2
Reservoirs

12-14 API
Heavy Oil

38,000
tonnes topside weight

2
billion barrels of oil in place

1981
Discovered

700
Long term jobs

22,000
tonnes jacket weight

250
millions barrels recoverable

30
Years of profitable production

>7
USD bn gross investment

Our journey

2012
Mariner FID

2013
Aberdeen office established

Start of Mariner jacket construction

2014
Start of Mariner FSU construction

Start of Mariner topsides construction

2015
Mariner jacket installation

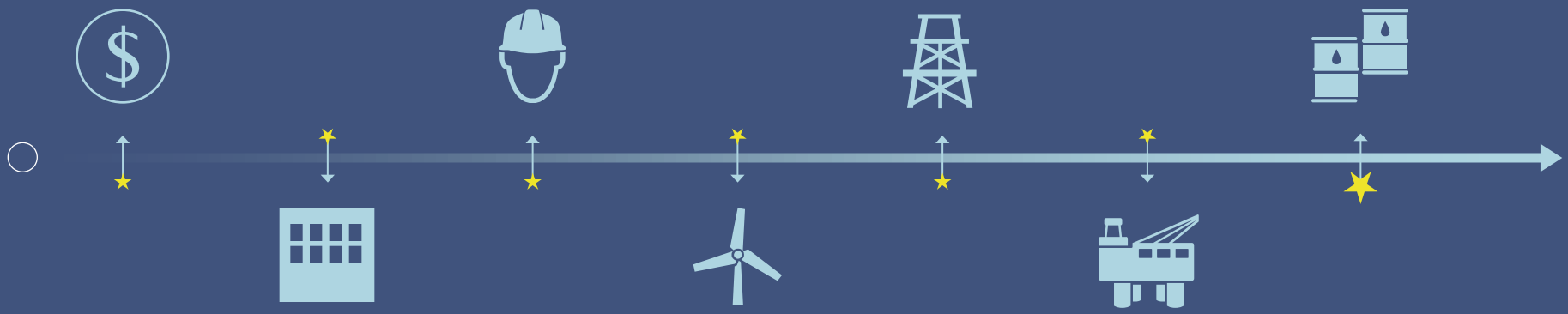
Sub sea installation

2016
Moving into new Statoil House

Start of Mariner drilling

2017
Mariner topsides installation
Hook-up and commissioning

2018
Mariner start-up



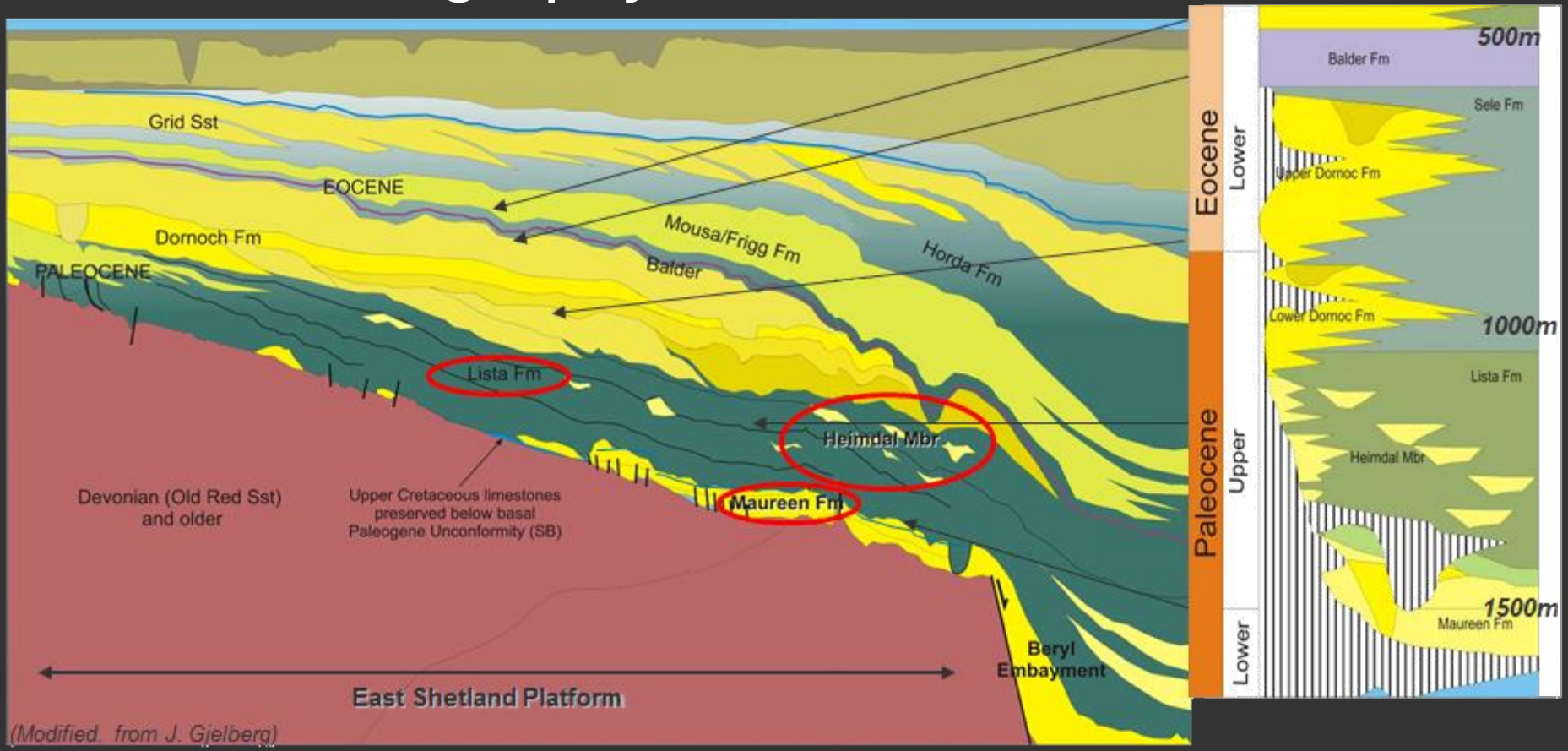
Mariner jacket and subsea infrastructure safely in place

Milestones ahead:

- 2016: Pre-drilling of production wells
- 2017: Hook-up and commissioning
- 2018: Start-up

Topside modules taking shape

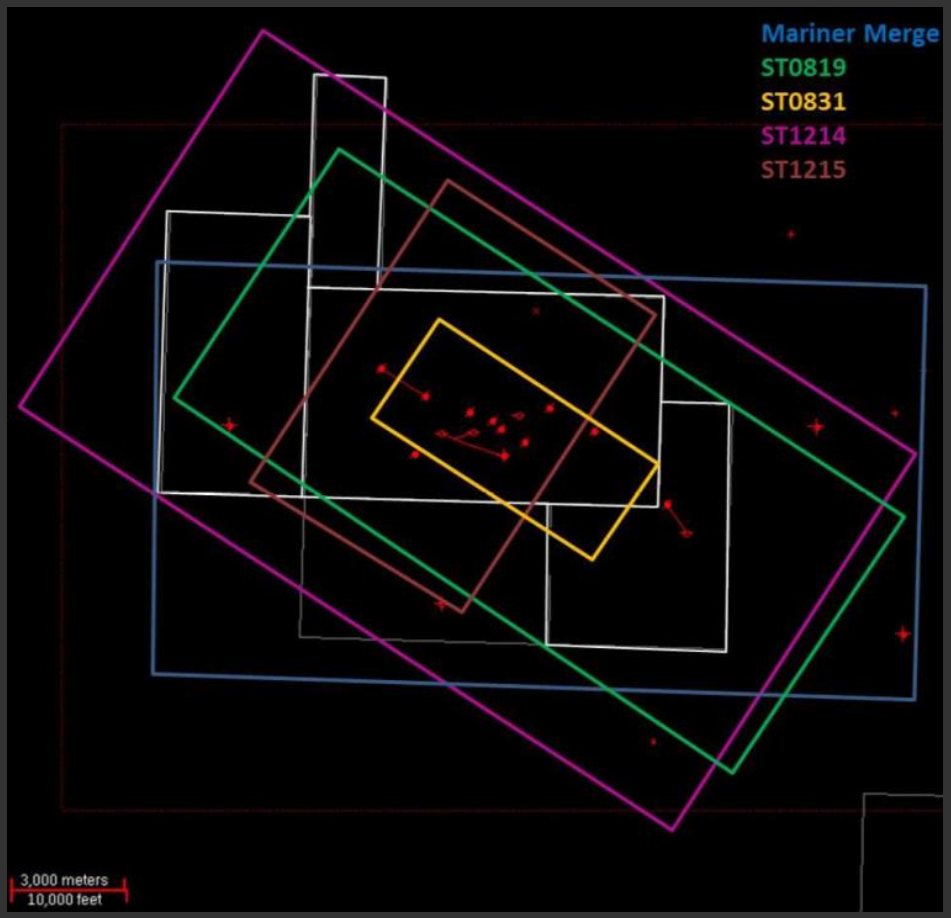
Mariner Stratigraphy



Two Reservoirs	API	Viscosity cP	Ø %	K Darcy	Temp. °C
Maureen	14	67	>30	2-5	46
Heimdal	12	508	>30	>10	38

Mariner Database

- P335, Block 9/11a, was awarded in 1980 with Mariner discovered by the 9/11- 1 well in 1981.
- A total of 5 3D seismic surveys have been acquired.
  - Plus a 2015 regional multiclient survey across the East Shetland Platform.
- A further 18 wells have been drilled.
  - plus 10 near field exploration wells.
- There have been 4 changes in operator owing to the perceived complexity of the field.
  - Heavy oil, unconsolidated sands, limited core data, washouts giving often poor log data and poor seismic imaging (vintage surveys) in particular for the Heimdal reservoir.



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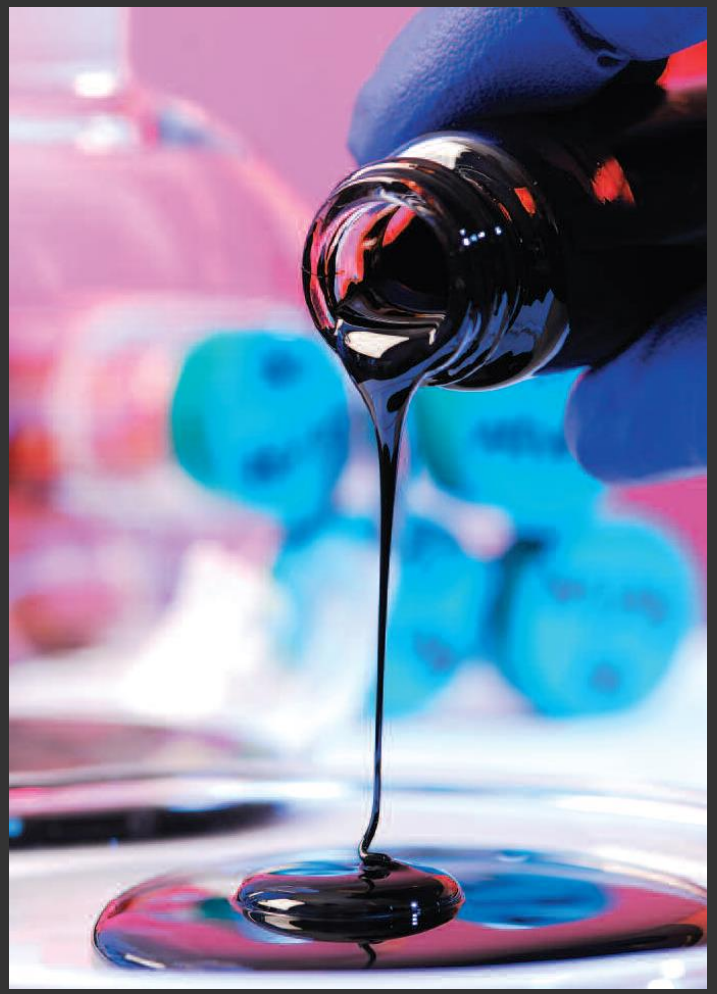
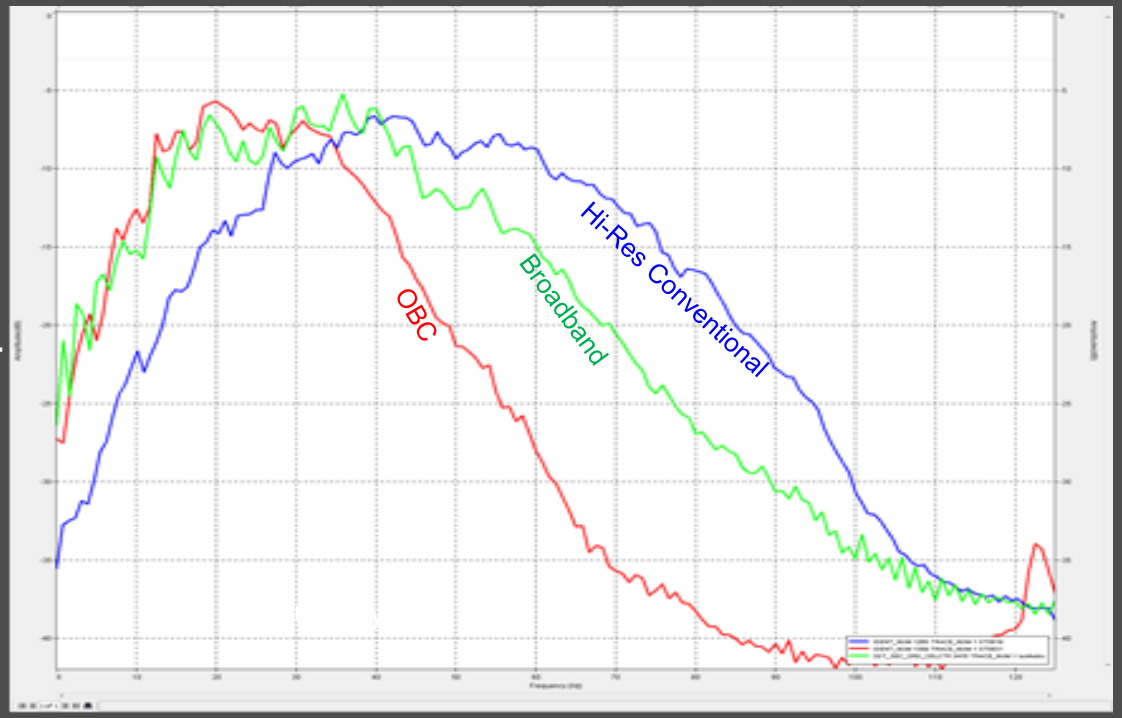


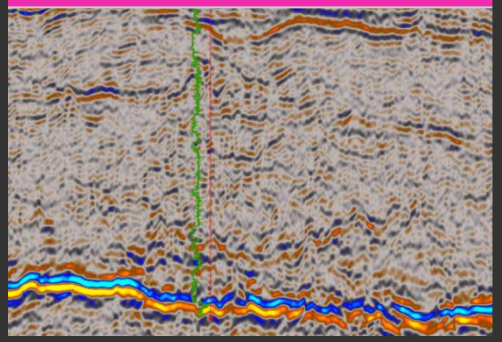
Statoil

Improving seismic imaging

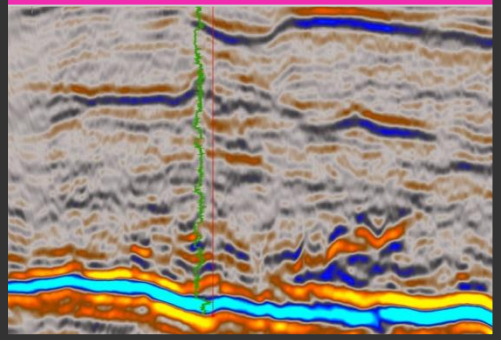
Wider frequency band, less noise, less side-lobes



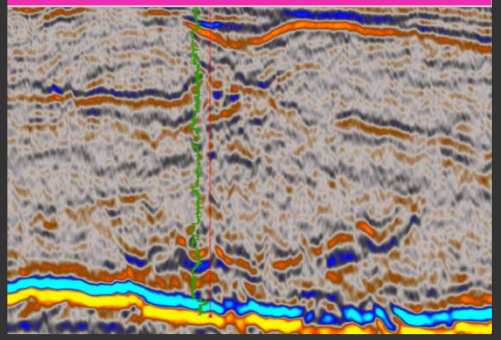
2008 Conventional Streamer Seismic



2008 OBC Seismic



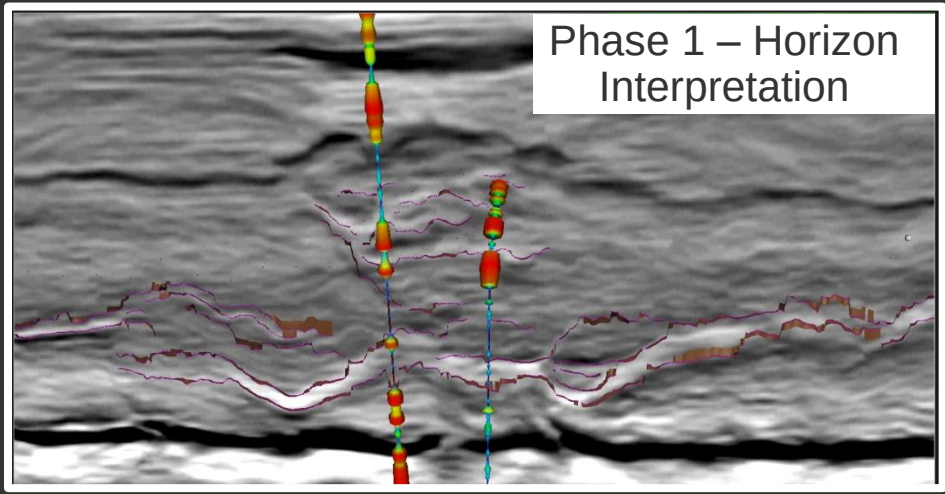
2012 Broadband Seismic

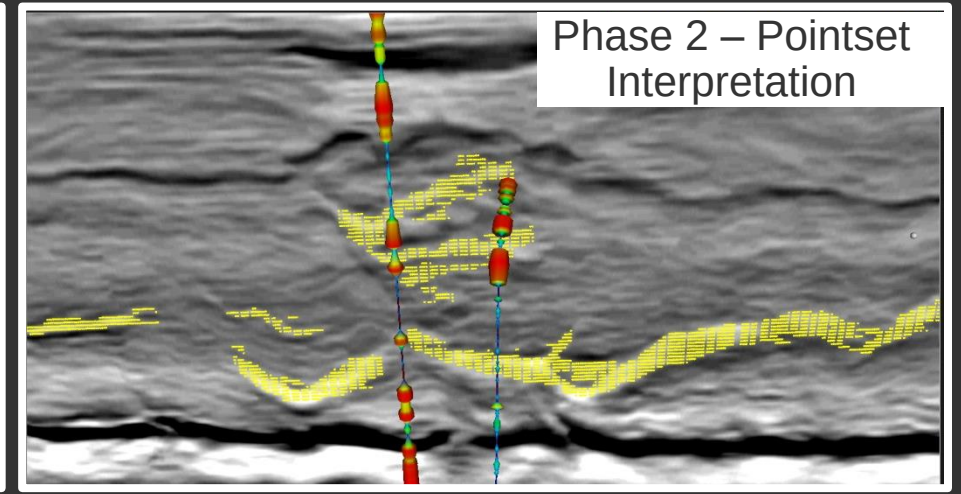


The once “invisible” Heimdal sands are illuminated on the core area OBC and full field broadband survey.

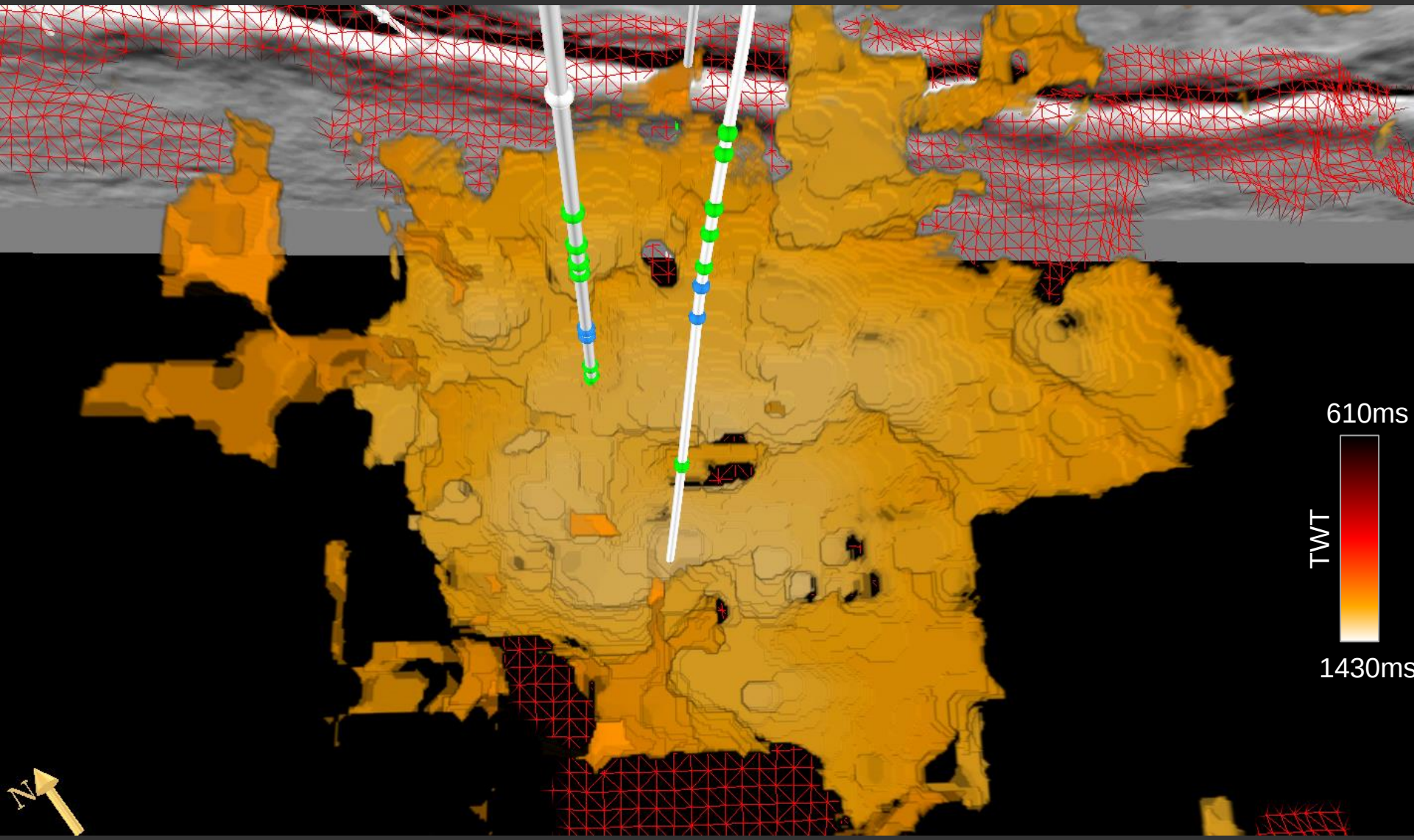
Geobody Interpretation

- Phase 1 vs. Phase 2 interpretation –
  - interpretation sets are reassuringly similar.
  - horizons are limited to single ‘z’ values therefore do not capture the complex connectivity between vertically offset injectites.
  - Points can be used to estimate sand thickness even when a top sand horizon is not present
    - ideally the inversion will remove all wavelet effects and compensate for tuning, therefore it should give truer thickness and localisation of thin bodies.
- Automated picking does not work in this setting as it picks up too much of the background.

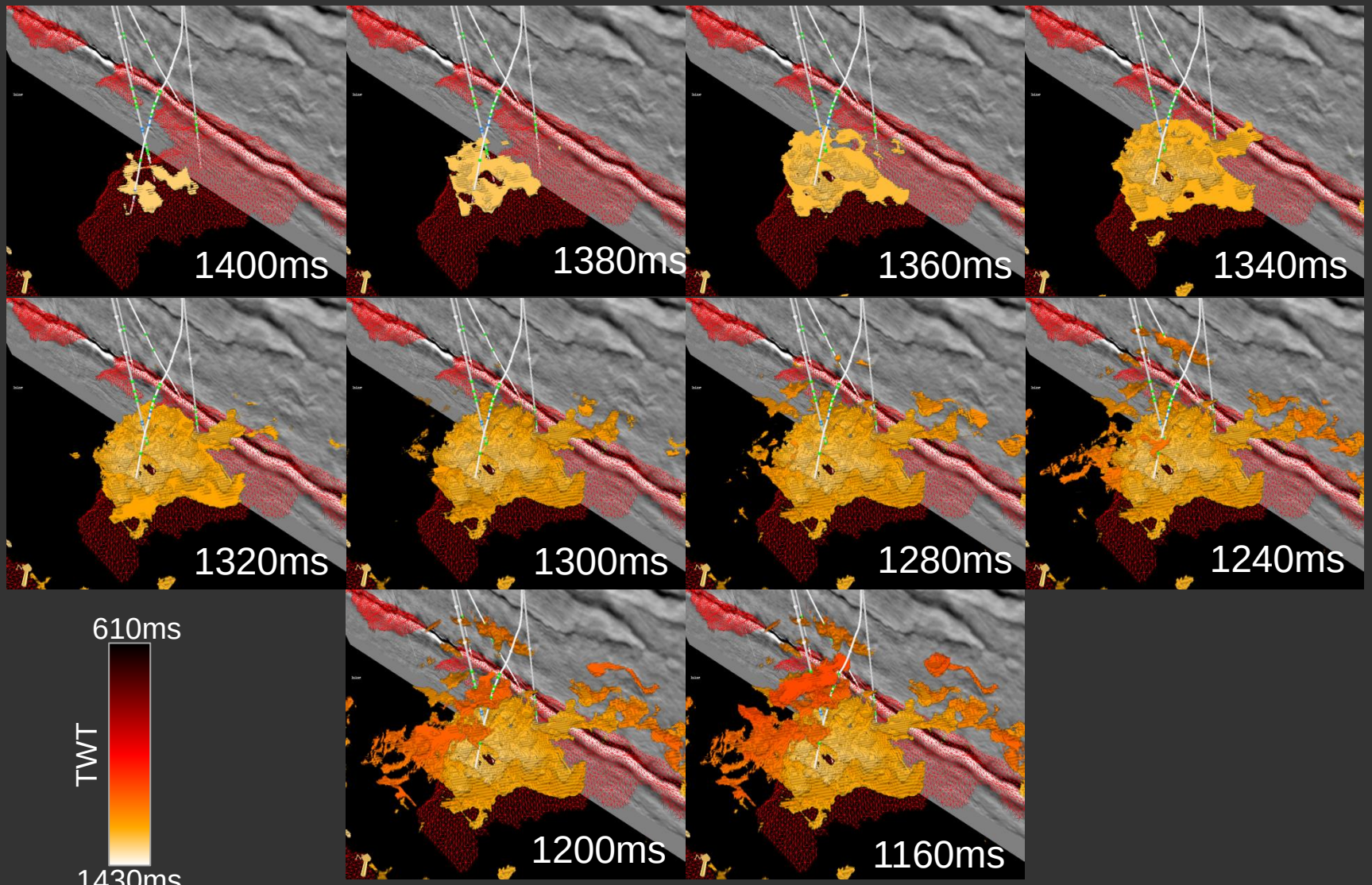




3D Geobody through oil filled sand



3D Geobody through oil filled sand



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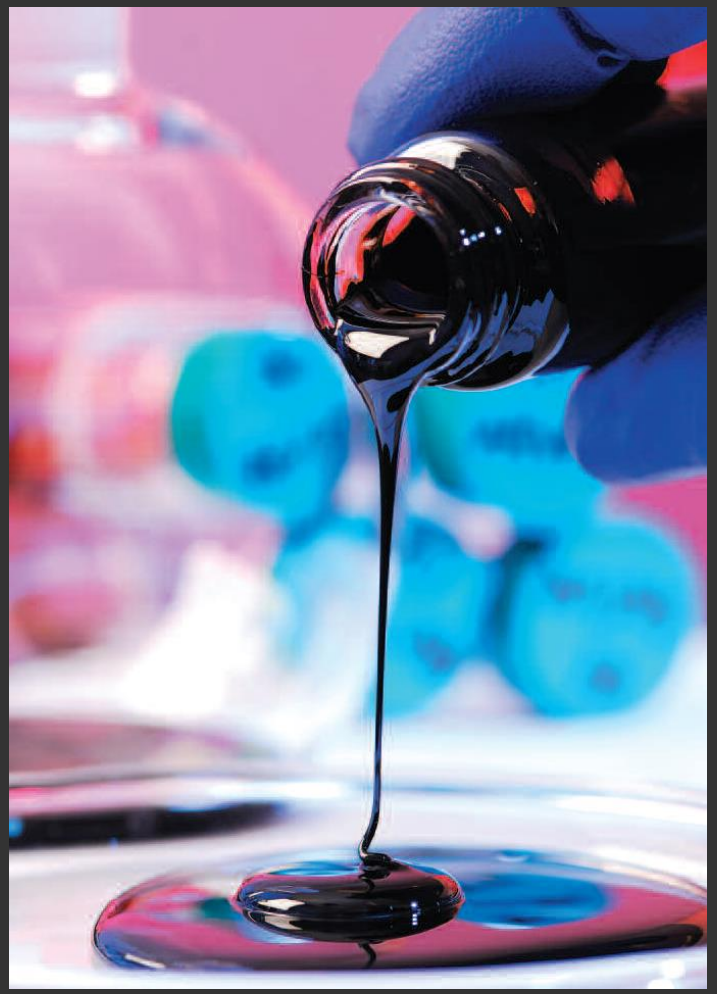
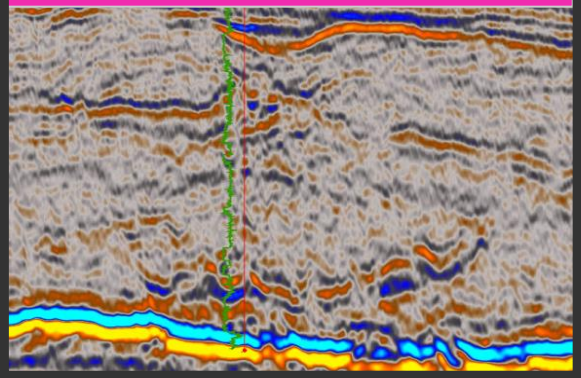


Statoil

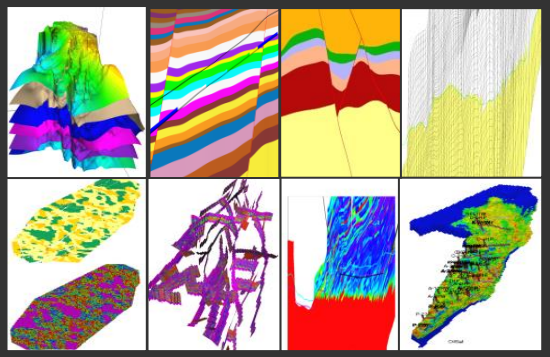
Unlocking Mariner Resources

Improved Seismic Interpretation



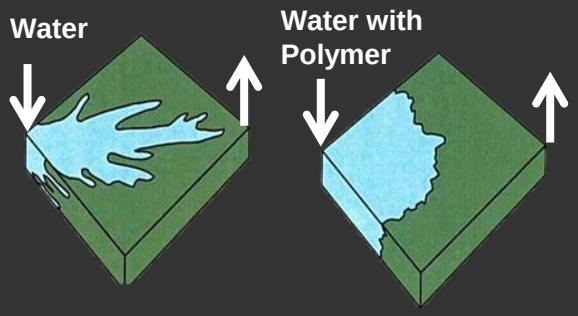
Objective: Better reservoir understanding

Fast Model Update



Objective: Efficient reservoir modeling workflow

Polymer Injection



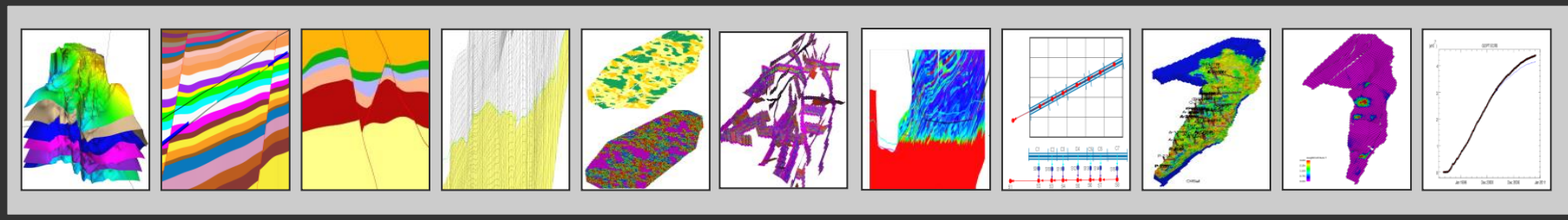
Objective: Improved reservoir sweep

From Seismic to Flow Modelling

Following Statoils Fast Model Update concept

Geophysics	Geomodelling	Reservoir engineering

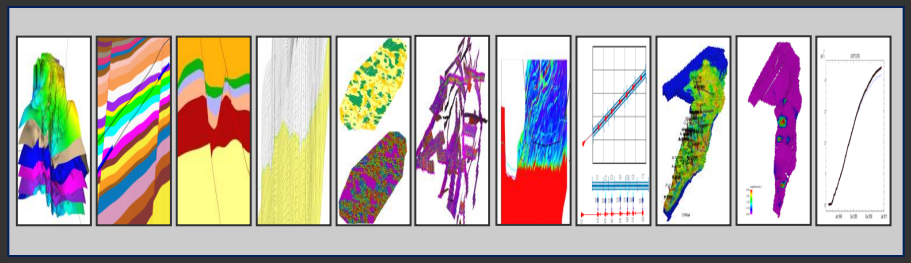
Depth conversion and structural modelling | **Gridding, facies and property modeling** | **Initialization, upscaling and wells** | **Flow simulations and predictions**



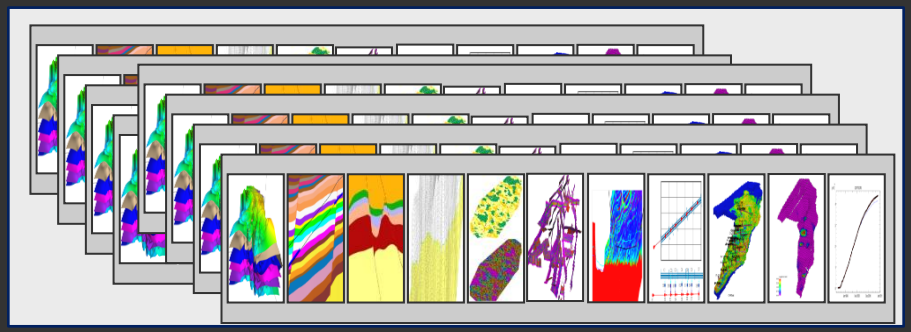
Traditional workflow for reservoir modeling:

- Loose coupling between disciplines
- Use of several software
- Time consuming
- Does not easily support the modeling and prediction of uncertainties
- A model update normally means we have to start all over again from scratch

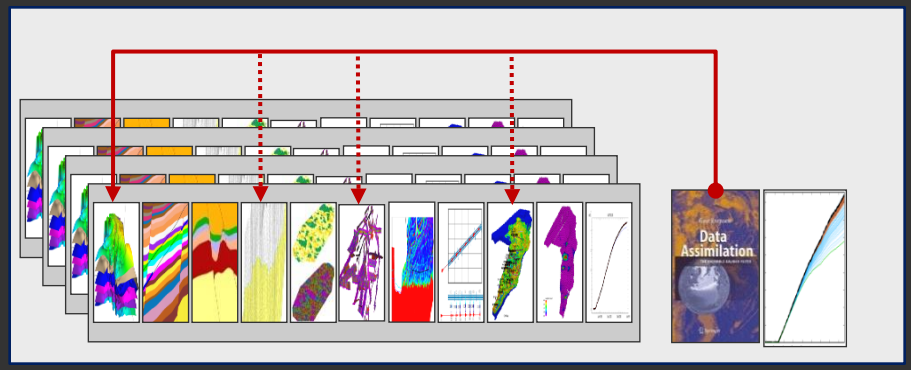
Fast Model Update



An automated model chain from depth conversion to simulation that is repeatable and updatable



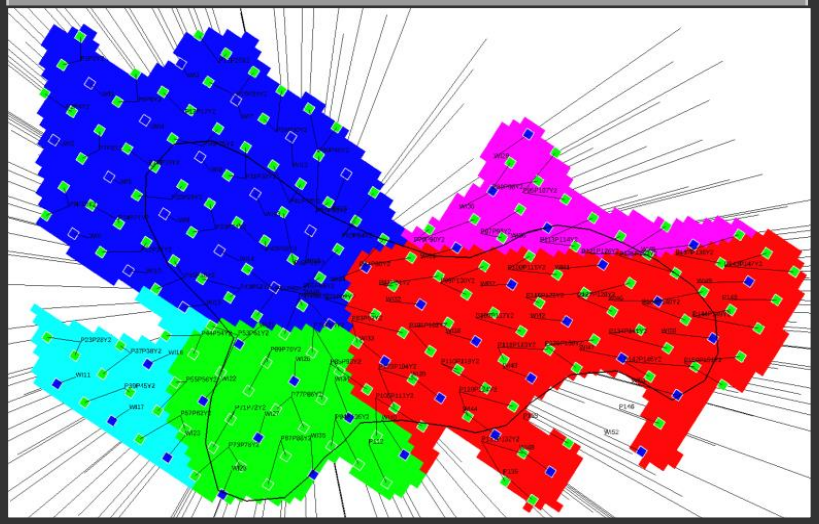
An ensemble framework for representation and prediction of uncertainty.



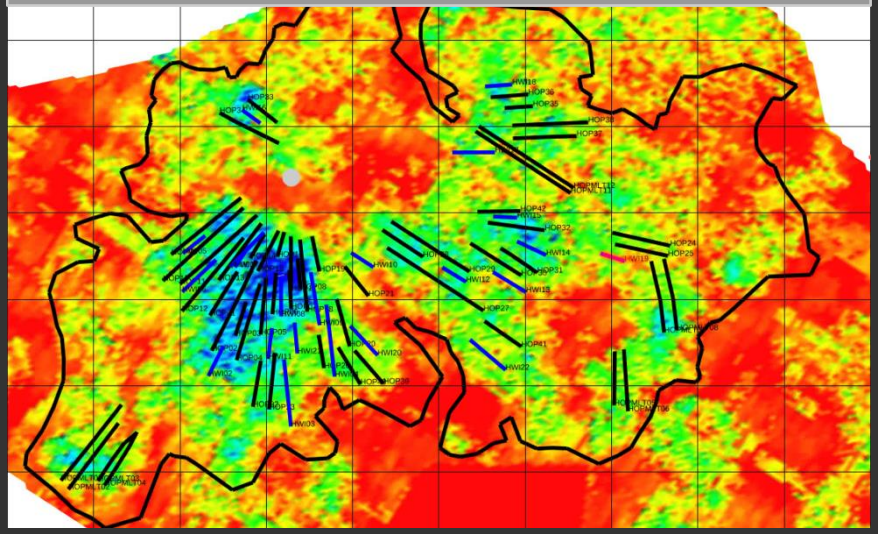
Ensemble methods for conditioning the model chain on dynamic data.

Heimdal Drainage Strategy

Heimdal Stochastic Model - 2012



Heimdal Deterministic Model - 2015



1. Risk Reduction

- ✓ Reduction in complexity
- ✓ Reduced in reservoir risk

2. Cost

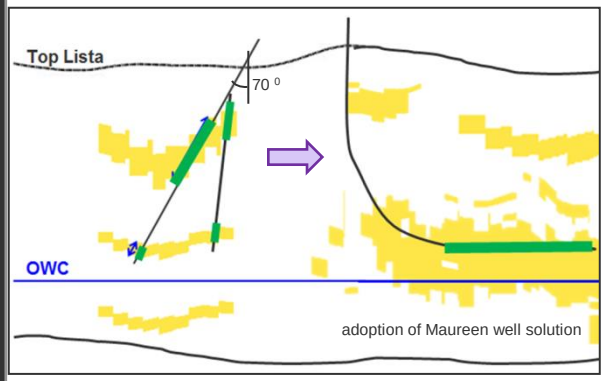
Cost reduction
~ 20% of
Heimdal Drillex

3. Production

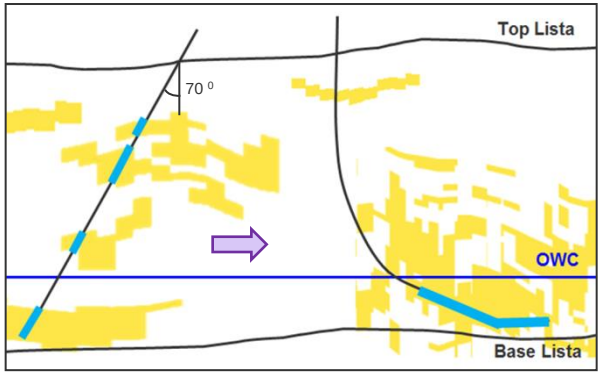
- ✓ Better areal coverage
  - ✓ Expected increase in reserves
- ✓ Significant infill drilling potential

Changes in Heimdal scope & well types
Sanction ➔ Pre-Development

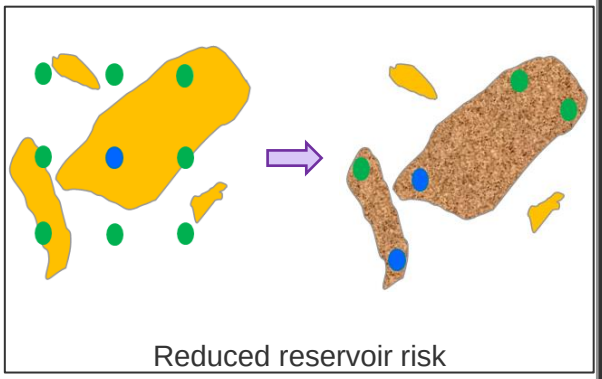
Heimdal Oil Producers



Heimdal Water Injectors



Heimdal Pilots and side tracks



Producers		
Sanction	➔	Pre-development
Dual lateral wells	➔	Horizontal wells

Injectors		
Sanction	➔	Pre-development
Slanted single wells	➔	Horizontal wells

Pilots & STs		
Sanction	➔	Pre-development
Reduced need for sidetracks and pilots		

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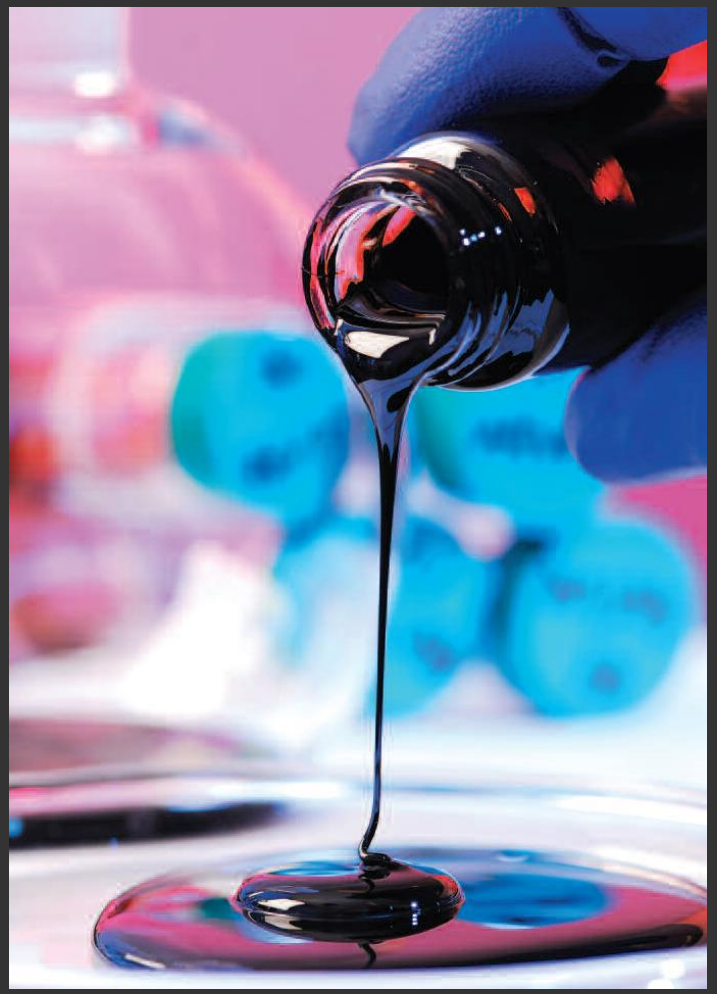
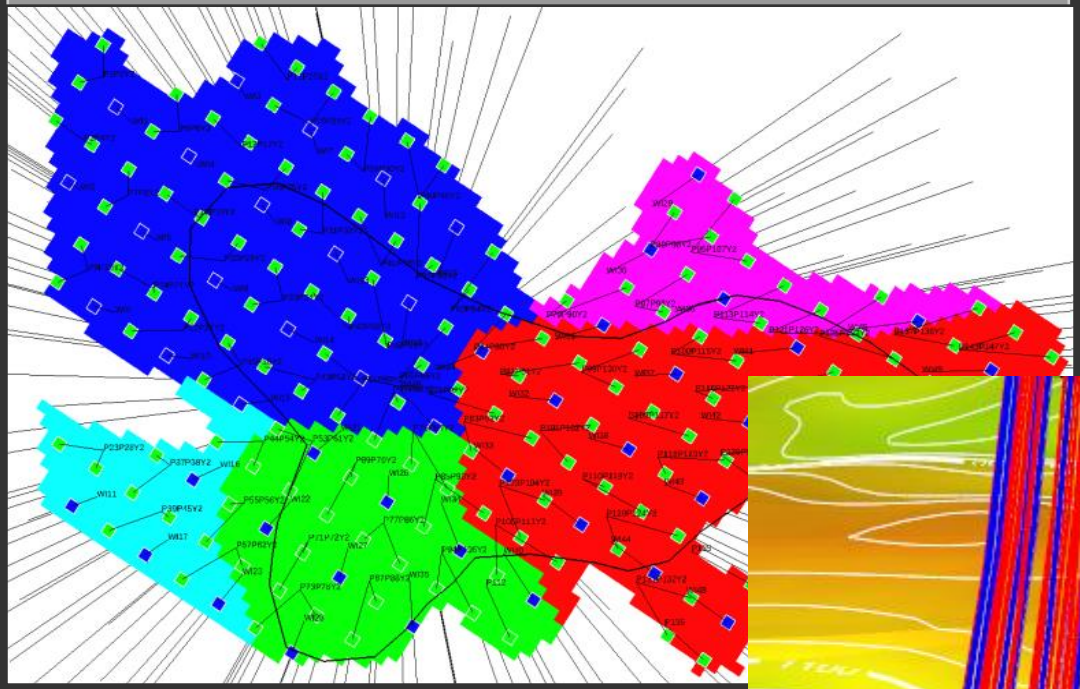


Statoil

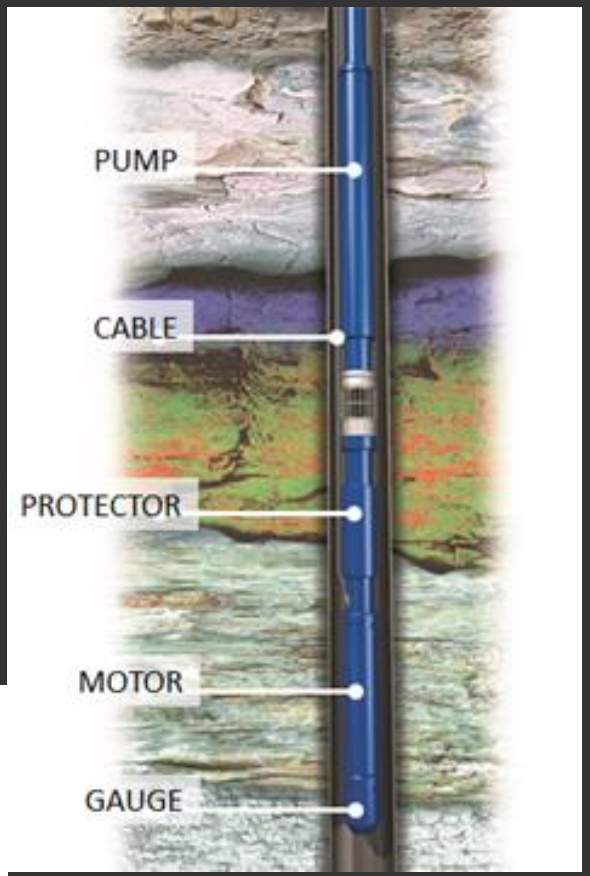
Anticollision...many Challenges

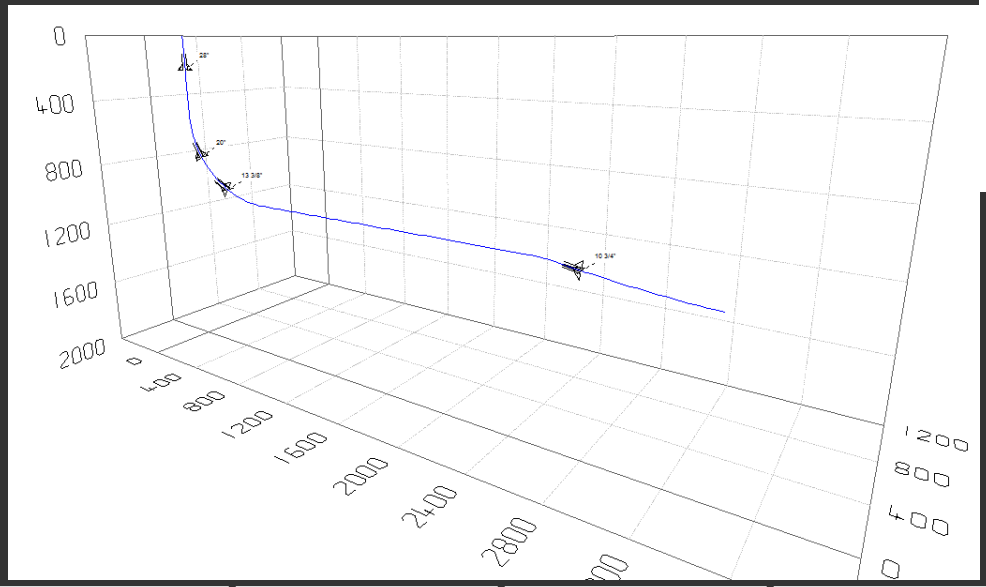
Heimdal Stochastic Model - 2012



Wellpath Analysis

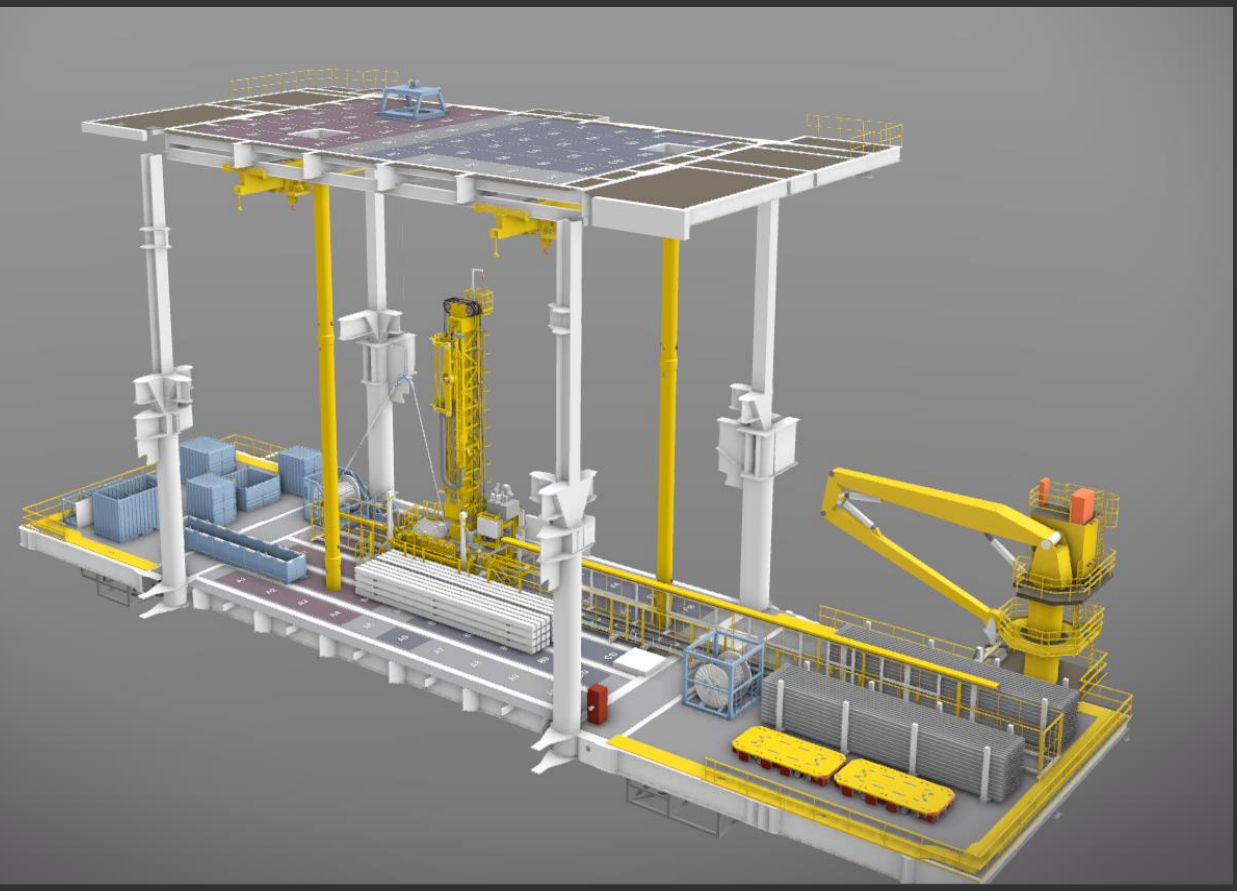
- Tangent section
  - 200m
  - Inclination < 85˚
- DLS no more than
  - While drilling: 4˚/30m (+/- 2˚ expected when drilling)
  - In reservoir section: 1.5˚/30m

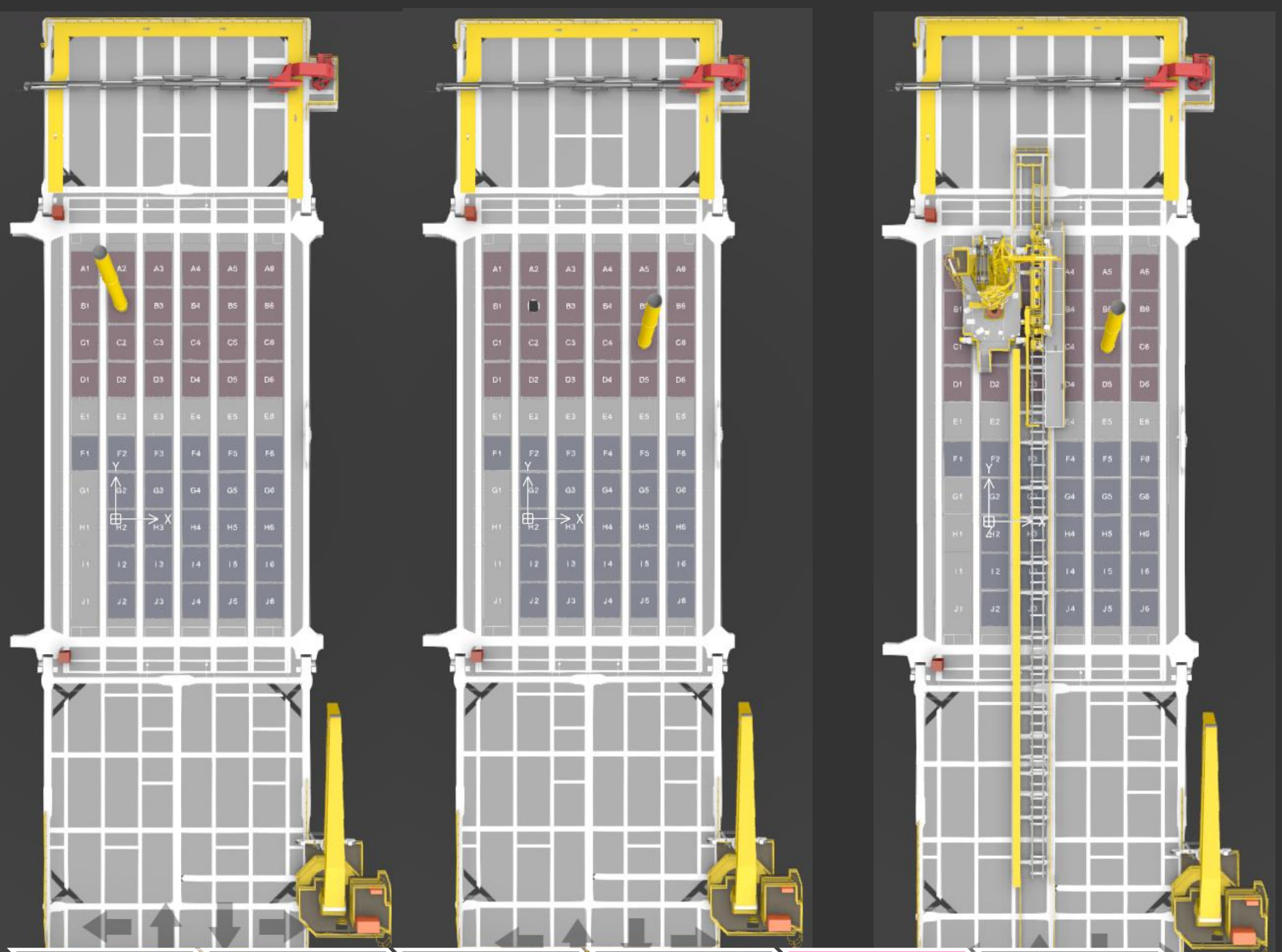


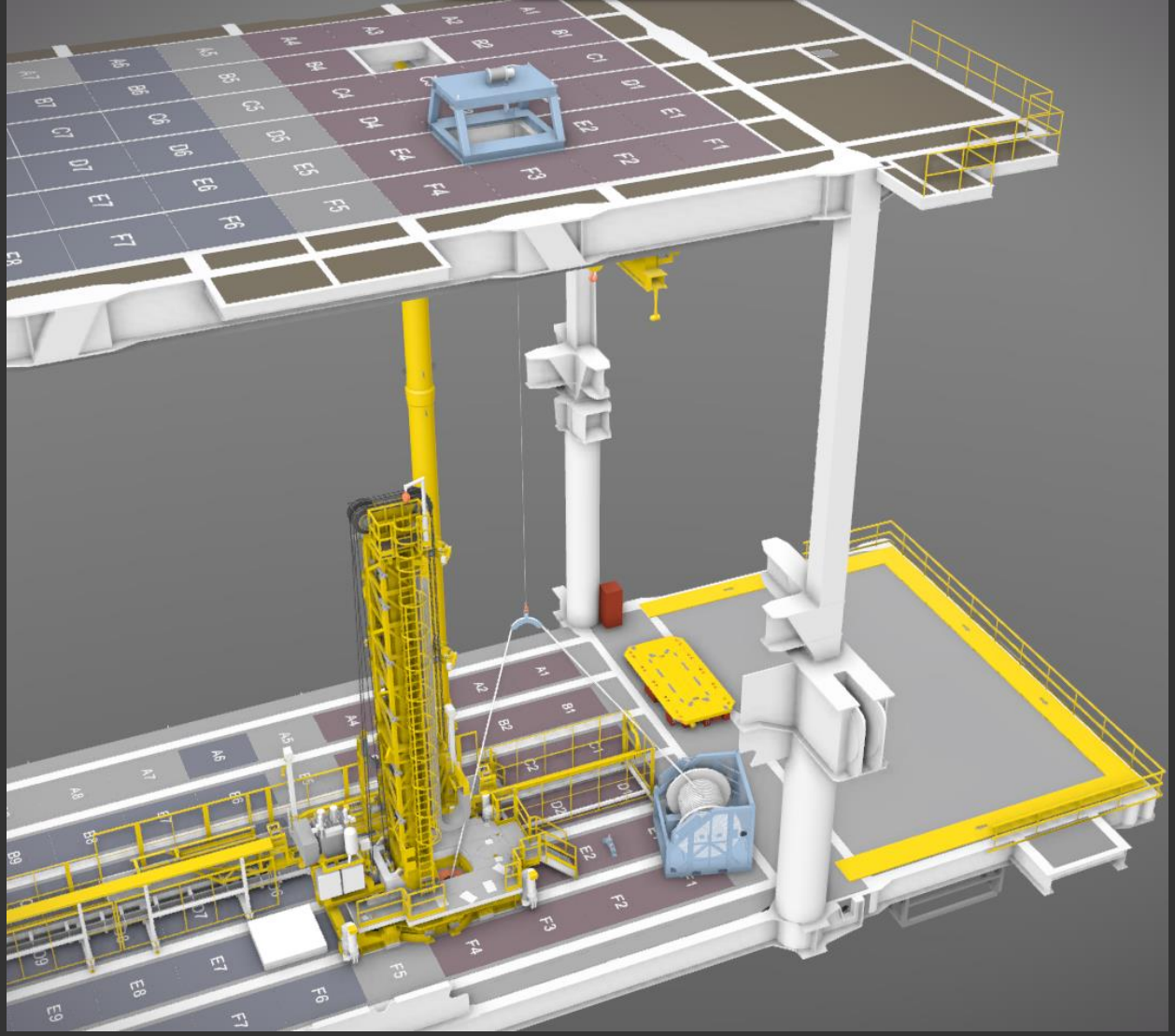


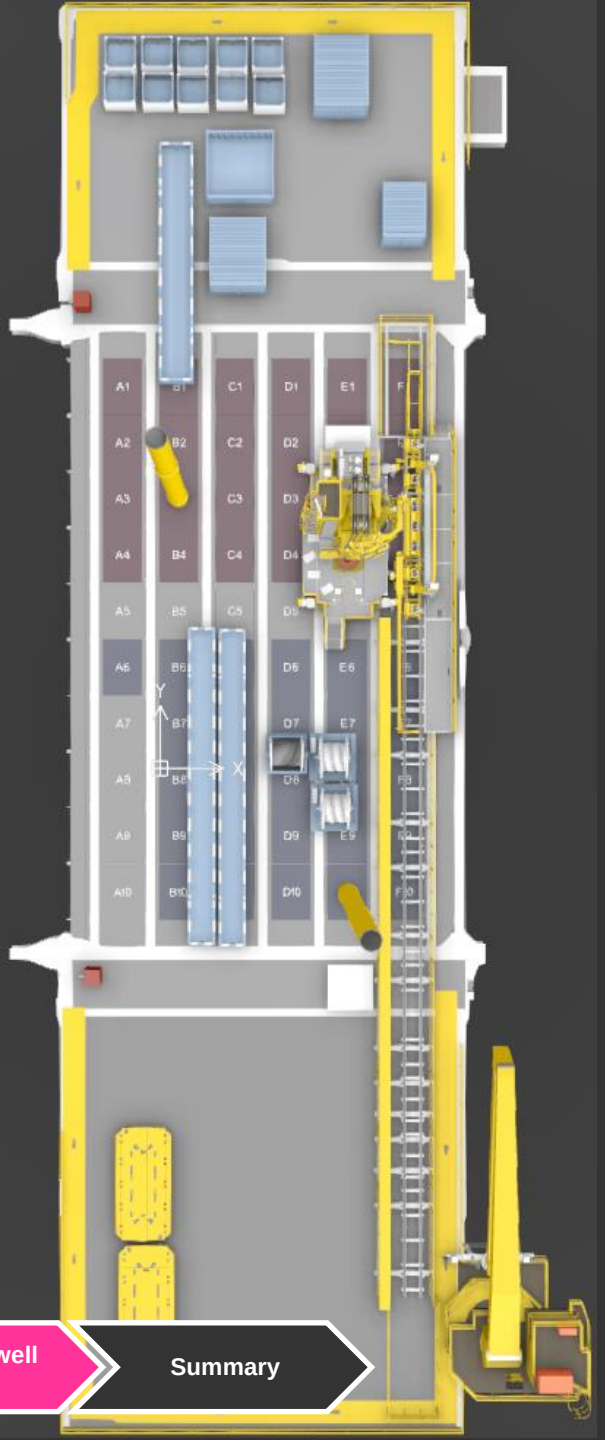
Mariner Platform with Jack-up rig

The Intervention and Completion Unit (ICU) area









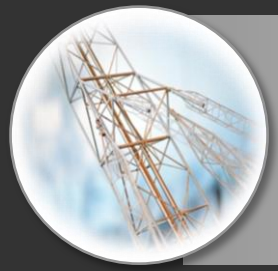
STEP projects improving our efficiency

End-to-end well delivery

- Standard well design, equipment and procedures
- Drilling execution excellence

Enabling OMM* excellence

- Reduced modifications portfolio
- Maintenance step-change
- Production efficiency gain



Strengthen early phase

- Right solution the first time
- Lean concepts

Supplier management and efficiency

- Purchasing discipline
- Spend control
- Value chain efficiency

Standardisation and industrialisation

- Maximise re-use and industry solutions
- Simplify technical requirements

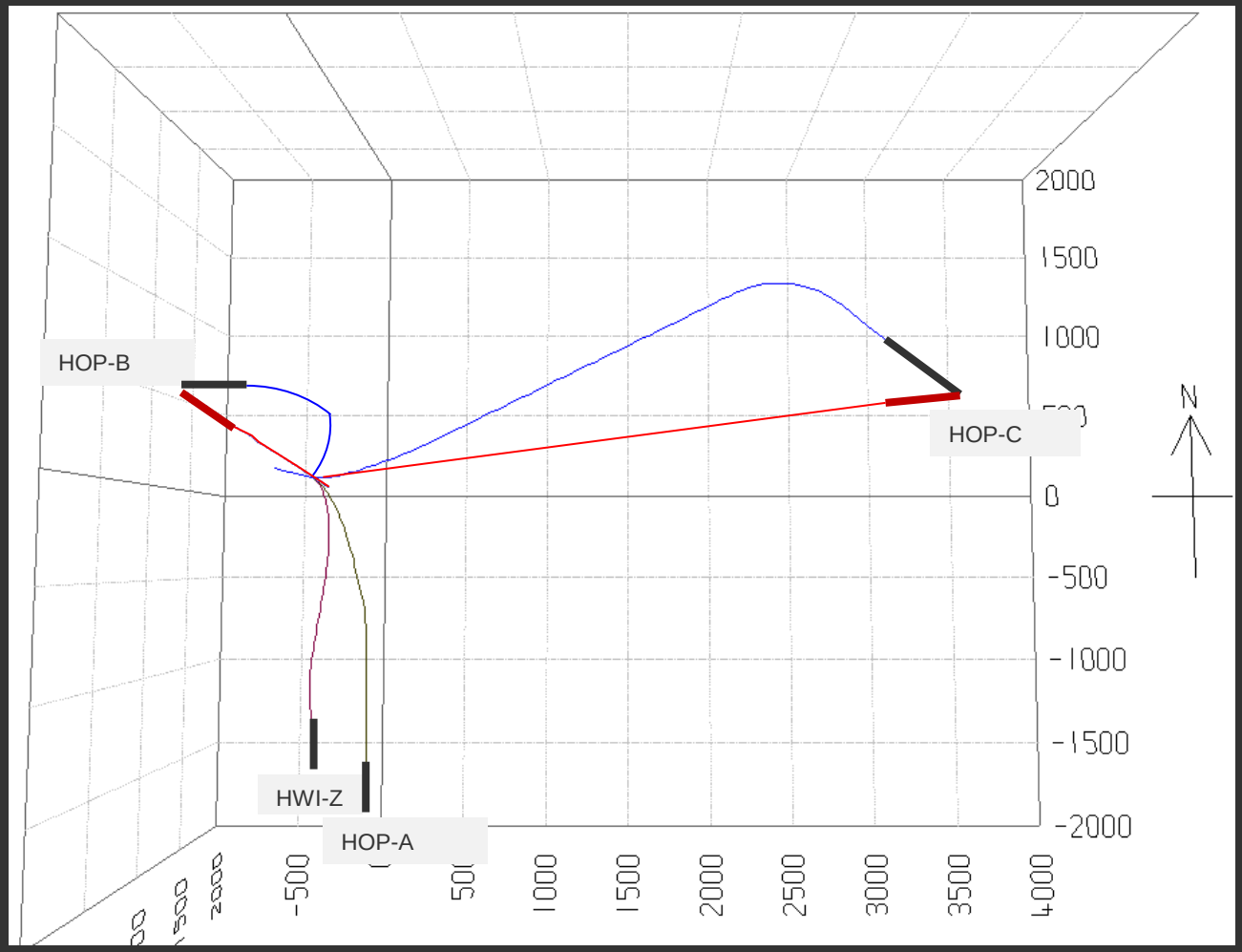
Simplification and resource prioritisation

- Increase staff efficiency
- Remove overlaps
- Simplify processes

Driving sustainable change through leadership and culture

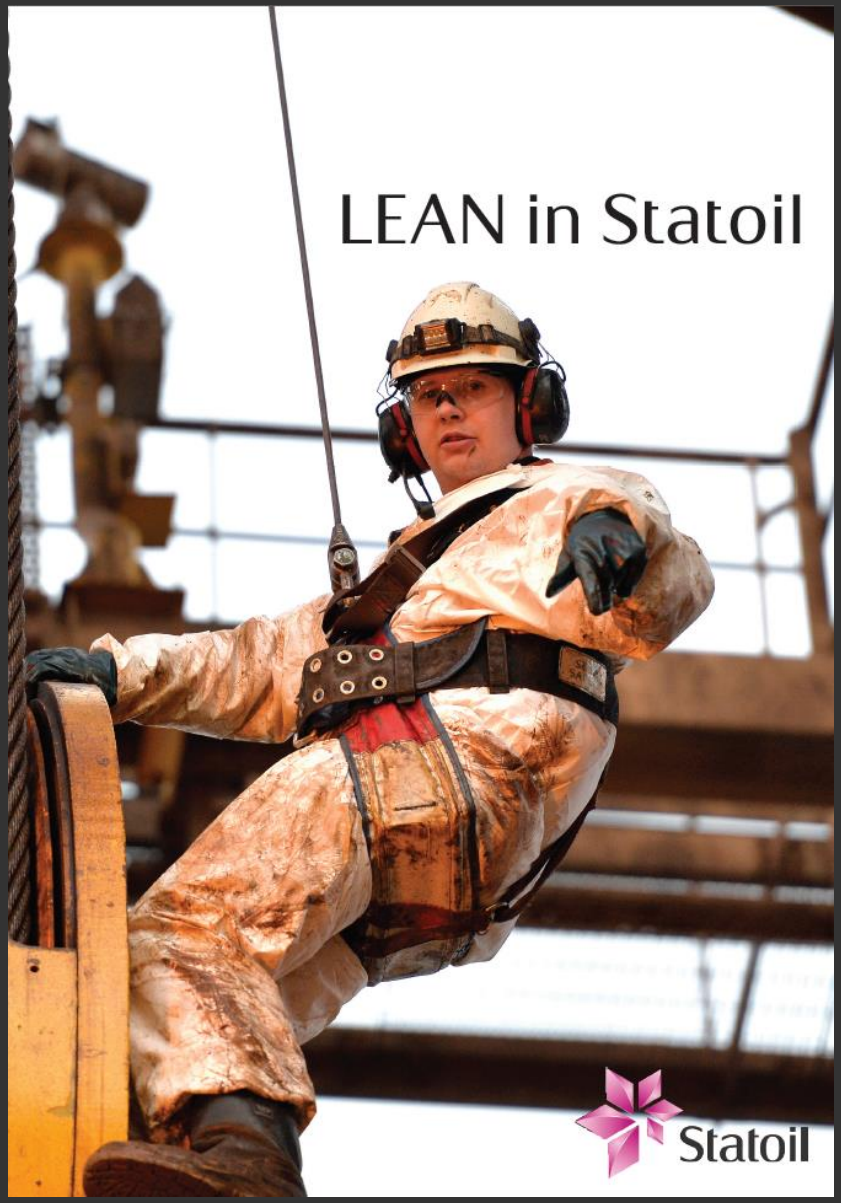
*OMM = Operations, maintenance & modifications

STEP in Action: Well Target Optimisation



Revised Drainage Strategy:

- Adjusting target orientation
- MLT to horizontal wells
- Reduced time and cost



LEAN in Statoil

- LEAN: A part of STEP
- A culture and method for continuous improvement
- Maximise Value creation
- Increase productivity
- Working smarter

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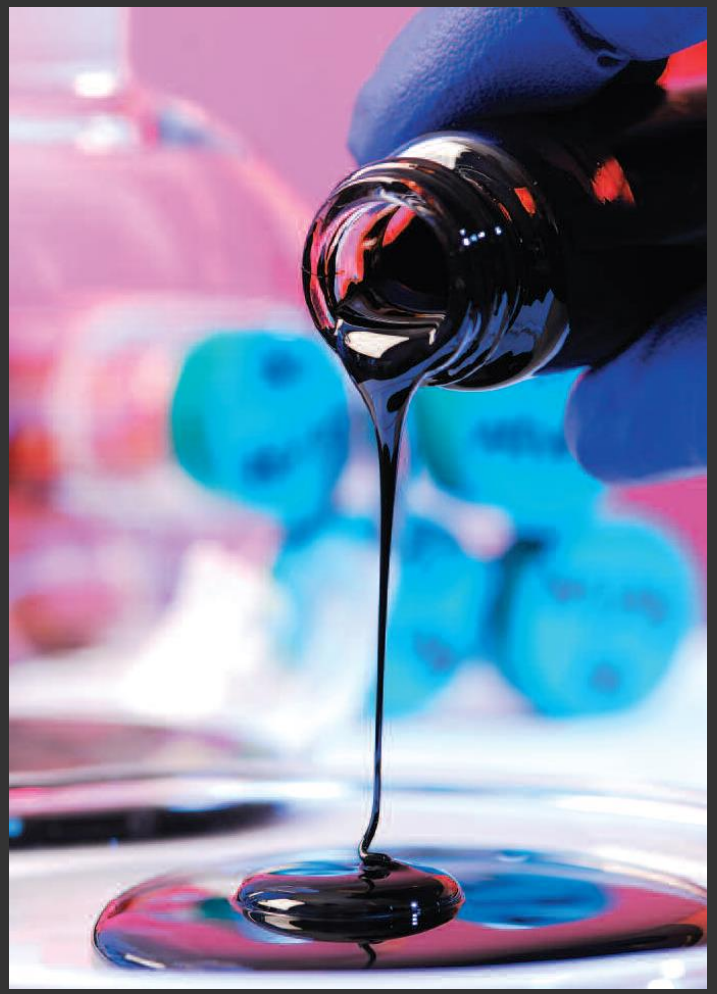


Statoil

Summary: Subsurface

Potential for increased recovery and reduced well cost

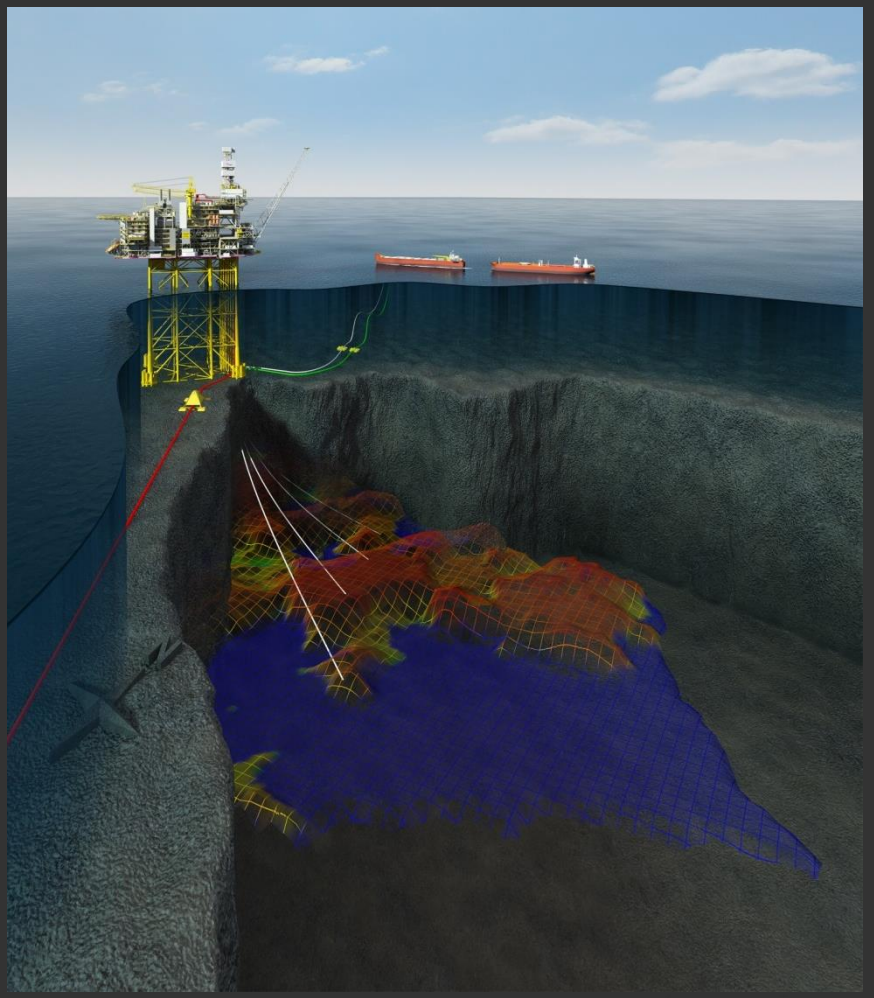
Maureen reservoir

- Reserves increased
- Potential for additional resources in undrilled segments

Heimdal reservoir

- New drainage strategy in 2016
- Accelerated production
- Potential for increased reserves
- Reduced well scope

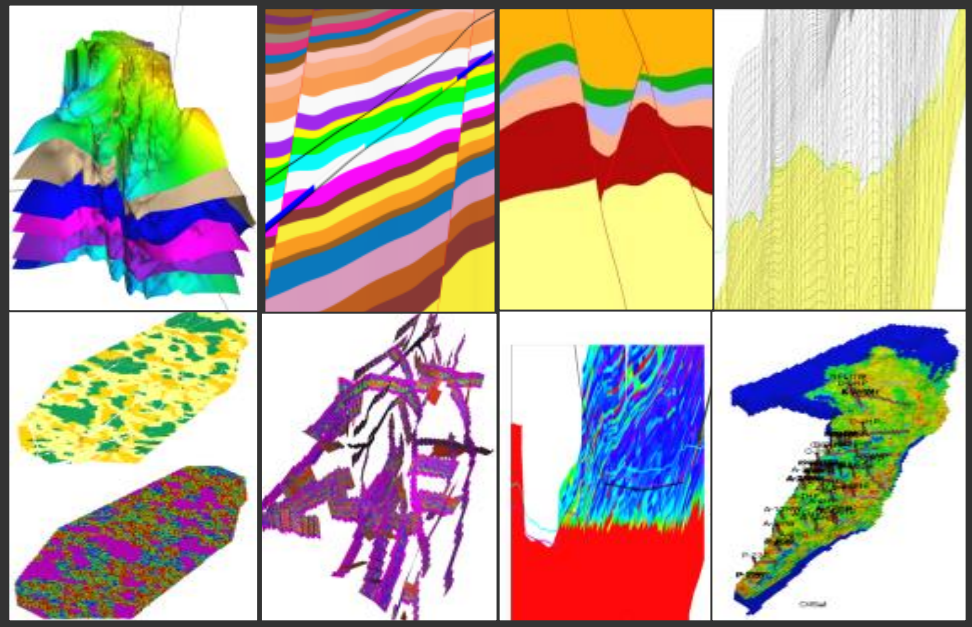
- Reduced drilling and completion risk through simplified well design



Summary: Collaboration

"Collaboration is energy. Leaders, teams, and individuals that tap into this source will find their work processes flowing better towards their goals" (Statoil How we work)

- Collaboration within Mariner has been a key part of our work process and this in turn has lead to:
  - Improved understanding of the Heimdal sand distribution.
  - A step change in the drainage strategy.
  - Simplified well design which in turn means lower risk wells at a lower cost.



The FMU process aids collaboration across disciplines.

Thank-you

Acknowledgements

- Statoil UK Limited – colleagues past and present.

And the Mariner partnership

- JX Nippon Exploration and Production (U.K.) Limited
- Dyas Limited

Statoil

Statoil. The Power of Possible

Statoil Production UK

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